# 6.0 BASELINE RISK ASSESSMENT

The Baseline Risk Assessment summarized in this section evaluates the potential human health and ecological effects associated with chemical contamination from past operations in the Northern Bush River Area, focusing on two separate evaluations of the RI analytical results for environmental media. The human health risk assessment evaluates the probability and magnitude of potential adverse effects on human health associated with actual or potential exposure to site-related chemicals. The screening-level ecological risk assessment evaluates the potential for adverse effects to ecological receptors and resources resulting from exposures to chemicals associated with the Northern Bush River Area. Appendix G contains the human health and screening-level ecological risk assessments. Section 7 presents the need for further action based on both regulatory and risk assessment derived criteria.

The human health and screening-level ecological risk assessments are consistent with Subpart E, Section 300.430(d) of the National Contingency Plan, which directs that a Baseline Risk Assessment be conducted to characterize the current and potential threats to public health and the environment posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain. The human health and screening-level ecological risk assessments are also consistent with USEPA guidance and standards (ICF Kaiser Engineers, Inc., 1997; IT Corporation, 2000).

## 6.1 Human Health Evaluation

The objectives of the human health risk assessment were to identify chemicals that could adversely effect human health, and eliminate COPCs that are unlikely to pose any risks under current and future land use scenarios. Separate conservative methodologies assessed the potentials for risk from detected carcinogenic and non-carcinogenic chemicals. Section 6.1.3 contains a summary of the quantitative risk estimates for each complete exposure pathway.

The assessment first summarized the validated chemical data results from groundwater, surface soil, subsurface soil, sediment, and surface water samples collected within the Northern Bush River Area. The assessment did not use data qualified as blank contamination or rejected. Based on a review of the data and comparison to appropriate risk-based screening levels, the risk assessment screening criteria identified COPCs for selection and quantitative evaluation in the human health risk assessment. Maximum concentrations of detected chemicals in each environmental medium were compared to RBCs in accordance with USEPA Region III guidance. The RBCs are health protective chemical concentrations that are back calculated using conservative exposure parameters. For the purposes of the risk assessment, RBCs back calculated from carcinogenic toxicity criteria

were used directly as screening criteria, while RBCs back calculated from non-carcinogenic toxicity criteria were adjusted downward by a factor of 10 for use as screening criteria. If the maximum detected chemical concentration was less than the RBC (or adjusted RBC for non-carcinogenic chemicals), the probability of contracting cancer would be less than one in one million, and adverse non-carcinogenic effects would not be expected to occur. As a result, the risk assessment retained for evaluation only chemicals detected at levels greater than RBCs (or adjusted RBCs).

Specifically identified COPCs in groundwater include chemicals detected in concentrations that exceed RBCs for tap water. Industrial soil RBCs were used to select surface soil COPCs throughout the majority of the Northern Bush River Area because the current and future land uses are most likely to be military industrial in nature. Residential soil RBCs were used to select surface soil COPCs in the Cluster 7 Boat Club Fill Sites, a small portion of the Northern Bush River Area where recreational exposures to military families could occur. Identified COPCs in subsurface soil were chemicals detected at concentrations that exceed industrial soil RBCs. RBCs for industrial and residential soil were used to select sediment COPCs. As with surface soil, RBCs for residential soil were used to select sediment COPCs only at the Cluster 7 Boat Club Fill Sites. In accordance with the risk assessment contractor's discussions with USEPA Region III, identified COPCs in surface water include chemicals detected in concentrations that are one order of magnitude above listed RBCs for tap water (termed recreational water RBCs). This screening level represents recreational exposures that are more likely to occur.

All organic compounds detected at concentrations above the RBCs and those chemicals lacking RBCs were selected as COPCs. Concentrations of inorganic compounds were further compared to data from the APG reference sampling and analysis program (ICF Kaiser Engineers, Inc., 1995a and b). Those inorganic concentrations within reference (background) level ranges were eliminated as COPCs. RBCs are not available for four essential human nutrients (i.e., calcium, magnesium, potassium, and sodium). Those nutrients detected at levels below Allowable Daily Intakes were considered unlikely to cause adverse effects and eliminated from evaluation. In accordance with the risk assessment contractor's discussions with USEPA Region III, the RBCs for arsenic were adjusted upward by an order of magnitude to account for uncertainty in the arsenic toxicological data.

In concurrence from USEPA Region III, the assessment next divided samples from each environmental medium into data groupings that describe conditions relevant to potential exposure by receptors or pertinent site environmental factors (e.g., hydrogeology and environmental setting). Groundwater sample results from 19 monitoring wells installed in the surficial aquifer were divided into three data groupings since no chemical plumes were identified. Cluster 7 contained groundwater samples from six wells, Cluster 35 contained samples from 10 wells, and Cluster 36

contained samples from three wells. Surface soil samples were divided in two data groupings. "Site-wide" soil contained all 30 samples and "Boat Club Fill Sites" soil contained five of the samples. The eight subsurface soils were combined into one data grouping. Sediment samples were divided in two data groupings. "Site-wide" sediment contained 13 samples and "Boat Club Fill Sites" sediment contained three of the samples. Surface water samples were divided in three data groupings. "Site-wide Marsh Areas" contained surface water samples from nine locations, "Site-wide Open Water Areas" contained samples from four locations, and "Boat Club Fill Sites - Open Water Areas" contained samples from three of the locations. Table 6-1 summarizes the COPCs identified in the Northern Bush River Area, which includes 11 organic and 14 inorganic compounds.

### 6.1.1 Exposure Assessment

The assessment next determined the potential pathways by which humans could be exposed to the identified COPCs in each environmental medium. Tables 6-2 and 6-3 summarize the selection of exposure pathways under current and future land use conditions, respectively in the Northern Bush River Area. With the exception of the Boat Club marina area, the majority of the Northern Bush River Area is primarily military industrial. Security personnel patrol the area, thereby limiting potential receptors to site (maintenance) workers, infrequent visitors, and trespassers. The Boat Club marina area has a parking lot and picnic area frequently used by military personnel and their families in the warmer seasons. Potentially affected personnel (receptors) under current land use conditions include site workers, hunters, trespassers (7 to 16 years of age), and youth visitors (4 to 16 years of age). The risk assessment assumed that exposures to other receptors (e.g., adult visitors) would be less frequent (lower) than these receptors. For informational purposes only, an attachment to the risk assessment presents potential risks to residential receptors.

Under current land use conditions, the following potential exposure pathways were quantitatively evaluated: trespasser exposures from dermal absorption of chemicals in surface water while wading at Site-wide Marsh Areas; and youth visitor exposures from incidental ingestion and dermal absorption of chemicals in sediment at the Boat Club Fill Sites and surface water while swimming at the Boat Club Fill Sites - Open Water Areas.

According to USEPA, a risk assessment evaluating potential future exposures should reflect the most reasonably anticipated future land uses. The exposure pathways for site workers, hunters, trespassers, and youth visitors evaluated under current land use conditions are not assumed to change; therefore, these receptors were not re-evaluated under future land use conditions. Future use of groundwater at the Northern Bush River Area is unlikely to occur since water is supplied to the area from an Army-owned water supply plant. Future exposures to subsurface

## Table 6-1. Summary of Chemicals of Potential Concern in the Northern Bush River Area

| Chemical | GROUNDWATER | | | SURFACE SOIL | | SUBSURFACE SOIL | SEDIMENT | | SURFACE WATER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cluster 7 | Cluster 35 | Cluster 36 | Site-wide | Boat Club Fill Sites | Site-wide | Site-wide | Boat Club Fill Sites | Site-Wide Marsh Areas | Site-Wide Open Water Areas | Boat Club Fill Sites – Open Water Areas |
| **Organics:** | | | | | | | | | | | |
| Benzo (a)pyrene | | | | | | X | | | | | |
| Alpha-BHC | | X | | | | | | | | | |
| Delta-BHC | | | | | | | X | | X | X | X |
| Chloroform | X | X | | | | | | | X | | |
| Chloromethane | | | | | | | | | X | | |
| Heptachlor | X | X | | | | | | | | | |
| Heptachlor epoxide | X | X | | | | | | | | | |
| 2-Hexanone | | | | | | X | | | | | |
| Methylphosphonic acid | X | | X | | | | | | X | | |
| 1,1,2,2-Tetrachloroethane | | X | | | | | | | X | | |
| N,N-bis(2,4,6-Trichlorophenyl)urea | | | | X | X | X | | | | | |
| **Inorganics:** | | | | | | | | | | | |
| Aluminum | | X | | | B | | | | | | |
| Antimony | | X | | | | | | | | | |
| Arsenic | X | B | B | | | | | | B | | |
| Beryllium | X | X | | B | B | | B | | B | B | X |
| Boron | X | X | | | | | | | | | |
| Cadmium | | B | | | | | | | | | |
| Chromium | | X | | | | | | | | | |
| Cobalt | | X | | | | | | | | | |
| Iron | X | X | X | | B | | | B | | | |
| Magnesium | | B | | | | | | | | | |
| Manganese | X | X | B | | B | | | B | | | |
| Nickel | | X | | | | | | | | | |
| Sodium | | X | | | | | | | | | |
| Thallium | | | | | | | | X | | | |

X - Selected as a COPC.
B - Inorganic chemical within reference levels, but above risk-based concentration or Allowable Daily Intake screening levels.
Shaded cells - Chemical lacks toxicity criteria and could not be quantitatively evaluated.

## Table 6-2. Potential Human Exposure Pathways under Current Land Use Conditions in the Northern Bush River Area

| Exposure Medium | Exposure Point | Potential Receptor | Exposure Route | Pathway Potentially Complete? Basis. | Method of Evaluation |
|---|---|---|---|---|---|
| Groundwater | On-site monitoring wells | None | None | No. Groundwater at the site is not currently used. | None |
| Surface Soil | Site-wide surface soil | Site Workers | Incidental ingestion and dermal absorption | Yes. Site workers could contact surface soil in the NBRA. However, no COPCs with available toxicity criteria were selected in the Site-wide surface soil grouping. | None |
| | | Hunters | Incidental ingestion and dermal absorption | Yes. Hunters could contact surface soil in the NBRA. However, no COPCs with available toxicity criteria were selected in the Site-wide surface soil grouping. | None |
| | | Trespassers | Incidental ingestion and dermal absorption | Yes. Trespassers could contact surface soil in the NBRA. However, no COPCs with available toxicity criteria were selected in the Site-wide surface soil grouping. | None |
| | Boat Club Fill Sites | Youth visitors | Incidental ingestion and dermal absorption | Yes. Youth visitors could contact surface soil at the Boat Club Fill Sites. However, no COPCs with available toxicity criteria were selected in the Boat Club Fill Sites surface soil grouping. | None |
| Subsurface soil | Site-wide subsurface soil | None likely | None | No. Subsurface soil is not available for contact, as excavations do not occur in the NBRA. | None |
| Sediment | Site-wide sediment | Site Workers | Incidental ingestion and dermal absorption | No. Site workers would only infrequently (if at all) contact sediment. In addition, no COPCs with available toxicity criteria were selected in the Site-wide sediment grouping. | None |
| | | Hunters | Incidental ingestion and dermal absorption | Yes. Hunters could contact sediment in the NBRA However, no COPCs with available toxicity criteria were selected in the Site-wide sediment grouping. | None |

## Table 6-2. Potential Human Exposure Pathways under Current Land Use Conditions in the Northern Bush River Area (Continued)

| Exposure Medium | Exposure Point | Potential Receptor | Exposure Route | Pathway Potentially Complete? Basis. | Method of Evaluation |
|---|---|---|---|---|---|
| Sediment (continued) | Site-wide sediment (continued) | Trespassers | Incidental ingestion and dermal absorption | Yes. Trespassers could contact sediment in the NBRA. However, no COPCs with available toxicity criteria were selected in the Site-wide sediment grouping. | None |
| | Boat Club Fill Sites | Youth Visitors | Incidental ingestion and dermal absorption | Yes. Youth visitors could contact sediment at the Boat Club Fill Sites. | Quantitative for incidental ingestion and dermal absorption of chemicals in sediment |
| Surface water | Site-wide Open Water Areas | Site Workers | Incidental ingestion and dermal absorption | No. Site workers would only infrequently (if at all) contact surface water in the Site-wide Open Water Areas. | None |
| | | Hunters | Incidental ingestion and dermal absorption | Yes. Hunters could contact surface water in the site wide Open Water Areas, but exposures would be less frequent (lower) than for trespassers evaluated under current land-use conditions. | None |
| | | Trespassers | Incidental ingestion and dermal absorption | Yes. Trespassers could contact surface water while swimming in Site-wide Open Water Areas. However, no COPCs with available toxicity criteria were selected in the Site-wide Open Water Areas data grouping. | None |
| | Boat Club Fill Sites Open Water Areas | Youth Visitors | Incidental ingestion and dermal absorption | Yes. Youth visitors could contact surface water and be exposed via incidental ingestion and dermal absorption while swimming at the Boat Club Fill Sites Areas. | Quantitative for incidental ingestion and dermal absorption of chemicals in surface water while swimming |
| Surface water | Site-wide Marsh Areas | Site Workers | Incidental ingestion and dermal absorption | No. Site workers would only infrequently (if at all) contact surface water in the Site-wide Marsh Areas. | None |
| | | Hunters | Incidental ingestion and dermal absorption | Yes. Hunters could contact surface water in the Site-wide Marsh Areas, but exposures would be less frequent (lower) than for trespassers evaluated under current land use conditions. | None |

## Table 6-2. Potential Human Exposure Pathways under Current Land Use Conditions in the Northern Bush River Area (Continued)

| Exposure Medium | Exposure Point | Potential Receptor | Exposure Route | Pathway Potentially Complete? Basis. | Method of Evaluation |
|---|---|---|---|---|---|
| Surface water (continued) | Site-wide Marsh Areas (continued) | Trespassers | Incidental ingestion and dermal absorption | Yes. Trespassers could surface water while wading in Site-wide Marsh Areas. Only the dermal route of exposure to surface water is considered complete for wading in marsh areas. | Quantitative for dermal absorption of chemicals in surface water while wading in marsh areas |
| Game animals | Game animals caught in the NBRA | Hunters | Ingestion of game animals | Yes. Although game animals could be exposed to COPCs in the NBRA, only low chemical concentrations were detected in surface soil, sediment, and surface water. Further, the NBRA would comprise only a small portion of the over all foraging range of the game animals. | None |
| Fish | Fish caught in NBRA | Fishermen | Ingestion of fish | Yes. Although, fishermen could ingest the fish they catch, chemical residues in fish would be associated with a much larger area than the NBRA. In addition, no chemical fish tissue data were available for evaluation in the risk assessment. | None |
| Air | Volatilized chemicals from groundwater or surface media in air | Individuals in the NBRA | Inhalation | No. Although VOCs were detected in groundwater, inhalation of groundwater VOCs is not expected to result in significant exposures due to dissipation into ambient air. Also, inhalation of VOCs could not be evaluated due to a lack of ambient air data. No VOCs with available toxicity criteria were detected in surface soil at concentrations exceeding respective RBCs, thus no significant volatilization of VOCs from soil would occur. | None |
| | Particulates of soil in air | Individuals in the NBRA | Inhalation | No. The study area is covered with vegetation and/or gravel minimizing the release of airborne particulates from soil. | None |

NBRA Northern Bush river Area
COPCS chemicals of potential concern
VOCs Volatile organic compounds
RBCs Risk-based concentrations

## Table 6-3. Potential Human Exposure Pathways under Hypothetical Future Land Use Conditions in the Northern Bush River Area

| Exposure Medium | Exposure Point | Potential Receptor | Exposure Route | Pathway Potentially Complete? Basis. | Method of Evaluation |
|---|---|---|---|---|---|
| Groundwater | On-site monitoring wells | Site Workers | Ingestion | Yes. Although it is unlikely that groundwater will be used in the NBRA, workers could install a well at the site and be exposed to COPCs in groundwater. | Quantitative for ingestion of groundwater |
| Subsurface Soil | On-site | Future excavation workers | Incidental ingestion and dermal absorption | Yes. Subsurface soil is available for contact if excavations are performed. | Quantitative for incidental ingestion and dermal absorption of chemicals in subsurface soil |

Pathways that occur under current land use conditions, and which could also occur under future land use conditions, are not presented again in this table.

soil at the Northern Bush River Area are unlikely to occur since any major development would be limited. However, in order to provide a complete evaluation of potential risks, the risk assessment evaluated exposures to site workers under future land use conditions. Under future land use conditions, the following potential exposure pathways were quantitatively evaluated: hypothetical, future site worker exposures from ingestion of chemicals in groundwater in all three groundwater data groupings; and future, excavation site worker exposures from incidental ingestion and dermal absorption of chemicals in subsurface soil.

Section 3.2 of the human health risk assessment explains the methodology used to determine reasonable maximum exposure point concentrations for the identified COPCs. Estimates of the exposure point concentrations for the COPCs in each environmental medium and timeframe are derived values based on the 95 percent upper confidence limit on the arithmetic mean concentration or the maximum detected concentration, whichever is lower. The reasonable maximum exposure point concentration for the COPCs in each environmental medium was assumed to represent the concentration in which receptors could be exposed at the Northern Bush River Area. Section 3.3 of the human health risk assessment lists the equations and exposure parameters for deriving dose estimates from the estimated exposure concentration data. Reasonable maximum estimate values for the extent, frequency, and duration of exposure, combined with the derived values for exposure point chemical concentrations, produce calculated chemical doses. Average daily doses and lifetime average daily doses were calculated using the potentially complete pathways and derived exposure point concentrations.

### 6.1.2 Toxicity Assessment

The assessment next performed the human toxicity assessment to identify quantitative toxicity criteria for the purpose of assessing human health exposures. As a result, data for each of the COPCs were compiled by listing the chemical's potential toxicity to humans and the chemical-specific, health-effects criteria. This compiled information is used in the quantitative assessment for the Northern Bush River Area. Chronic-toxicity criteria and quantitative, dose-response data were obtained from the USEPA's Integrated Risk Information System, Health Effects Assessment Summary Tables, and the National Center for Environmental Assessment.

Health criteria are developed for chemicals based on whether exposures are associated with carcinogenic effects, non-carcinogenic effects, or both. Potential risks from the pesticide delta-BHC, the VOC 2-hexanone, clothing impregnate degradation product TCPU, and two essential human nutrients (i.e., magnesium and sodium) could not be quantitatively evaluated because toxicity data are not available. Exclusion of these chemicals is not anticipated to result in significant underestimates of risk. Tables 4-1 and 4-2 in the risk assessment list carcinogenic and

non-carcinogenic toxicity data, health-effects criteria of each COPC for the oral and dermal exposure routes.

### 6.1.3 Risk Characterization

The human health risk characterization for the Northern Bush River Area uses the selected exposure pathways and average daily doses calculated in the exposure section combined with the health-effects criteria presented in the toxicity section to quantitatively assess potential human health risks. Table 6-4 presents quantitative risks associated with current and future exposures of COPCs to receptors. Table 6-5 presents quantitative cumulative risks associated with current and future exposures to receptors. The estimated, upper bound excess lifetime cancer risks for the Northern Bush River Area were compared to USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ for health protectiveness at CERCLA sites. The estimated non-carcinogenic hazard indices were compared to 1; values greater than 1 indicate a potential for adverse health effects. The following results present the potential cancer risks and non-carcinogenic hazard indices for each receptor quantitatively evaluated in the human health risk assessment.

Under current land use conditions, the excess lifetime cancer risk to trespasser exposures from dermal absorption of chemicals in surface water while wading at "Site-wide Marsh Areas" totaled $2x10^{-8}$, and the hazard index was less than 1. Cumulative risk estimates were not calculated since trespassers were each assumed to be exposed to chemicals in surface water from only one pathway, dermal absorption.

Under current land use conditions, the excess lifetime cancer risk to youth visitor exposures from incidental ingestion and dermal absorption of thallium in sediment at the "Boat Club Fill Sites" were not calculated since thallium does not have available carcinogenic toxicity criteria. The hazard indices were less than 1. The excess lifetime cancer risks to youth visitor exposures from incidental ingestion and dermal absorption of chemicals in surface water while swimming at the "Boat Club Fill Sites - Open Water Areas" were $6x10^{-8}$ and $3x10^{-6}$, respectively. The hazard indices were both less than 1. The potential cumulative risk for youth visitors was $3x10^{-6}$, which is at the low end of USEPA's target risk range for health protectiveness. The cumulative hazard index was less than 1, indicating that adverse effects would most likely not occur.

Under future land use conditions, potential risks to hypothetical, future site workers from ingestion of chemicals in groundwater in all three groundwater data groupings were quantified. Cumulative risk estimates were not calculated since each site workers was assumed to be exposed to chemicals in groundwater from only one pathway, ingestion. The excess lifetime cancer risk to future site workers from ingestion of the Cluster 7 groundwater grouping totaled $6x10^{-5}$, and was

## Table 6-4. Risks Associated with Exposures at the Northern Bush River Area

| Receptor/Pathway | Cancer Risk | Predominant Chemicals* | Non-cancer Hazard Index | Predominant Chemicals* |
|---|---|---|---|---|
| **CURRENT LAND-USE CONDITIONS** | | | | |
| **Trespasser:** | | | | |
| Surface Water (Site-wide Marsh Areas) | | | | |
| Dermal Contact | $2x10^{-8}$ | --- | <1 ($3x10^{-5}$) | --- |
| **Youth Visitor:** | | | | |
| Sediment (Boat Club Fill Sites) | | | | |
| Incidental Ingestion | --- | --- | <1 ($6x10^{-3}$) | --- |
| Dermal Contact | --- | --- | <1 ($2x10^{-3}$) | --- |
| Surface Water (Boat Club Fill Sites – Open Water Areas | | | | |
| Incidental Ingestion | $6x10^{-8}$ | --- | <1 ($1x10^{-5}$) | --- |
| Dermal Contact | $3x10^{-6}$ | Beryllium | <1 ($7x10^{-4}$) | --- |
| **FUTURE LAND-USE CONDITIONS** | | | | |
| Receptor/Pathway | Cancer Risk | Predominant Chemicals* | Non-cancer Hazard Index | Predominant Chemicals* |
| **Site Worker:** | | | | |
| Groundwater (Cluster 7) | | | | |
| Ingestion | $6x10^{-5}$ | Arsenic, beryllium | 2 | Iron |
| Groundwater (Cluster 35) | | | | |
| Ingestion | $4x10^{-5}$ | beryllium | 2 | Iron |
| Groundwater (Cluster 36) | | | | |
| Ingestion | --- | --- | 2 | Iron |
| **Excavation Worker:** | | | | |
| Subsurface Soil | | | | |
| Incidental Ingestion | $6x10^{-7}$ | --- | --- | --- |
| Dermal Contact | $4x10^{-7}$ | --- | --- | --- |

* The predominant chemicals were associated with a cancer risk greater than $1x10^{-6}$ or a hazard index greater than 1.

## Table 6-5. Cumulative Risks Associated with Exposures at the Northern Bush River Areas

| CURRENT LAND-USE CONDITIONS | | |
|---|---|---|
| Receptor/Pathway | Cancer Risk | Non-cancer Hazard Index |
| **Youth Visitor:** | | |
| Sediment (Boat Club Fill Sites) | | |
| Incidental Ingestion | --- | <1 ($6x10^{-3}$) |
| Dermal Contact | --- | <1 ($2x10^{-3}$) |
| Surface Water (Boat Club Fill Sites – Open Water Area) | | |
| Incidental Ingestion | $6x10^{-8}$ | <1 ($1x10^{-5}$) |
| Dermal Contact | $3x10^{-6}$ | >1 ($7x10^{-4}$) |
| **Cumulative Risk** | **$3x10^{-6}$** | **<1 ($9x10^{-3}$)** |
| **FUTURE LAND-USE CONDITIONS** | | |
| Receptor/Pathway | Cancer Risk | Non-cancer Hazard Index |
| **Excavation Worker:** | | |
| Subsurface Soil | | |
| Incidental Ingestion | $6x10^{-7}$ | --- |
| Dermal Contact | $4x10^{-7}$ | --- |
| **Cumulative Risk** | **$1x10^{-6}$** | --- |

primarily associated with exposures to arsenic. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 1 for iron, which is not associated with a specific target organ.

The excess lifetime cancer risk to future site workers from ingestion of the Cluster 35 groundwater grouping totaled $4x10^{-5}$, and was primarily associated with exposures to beryllium. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 1 for iron, which is not associated with a specific target organ.

The excess lifetime cancer risk to future site workers from ingestion of the Cluster 36 groundwater grouping was not calculated since none of the selected COPCs have available carcinogenic toxicity criteria. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 2 for iron, which is not associated with a specific target organ.

Under future land use conditions, potential risks to future excavation workers were quantified. The excess lifetime cancer risks to excavation worker exposures from incidental ingestion and dermal absorption of benzo(a)pyrene in subsurface soil were $6x10^{-7}$ and $4x10^{-7}$, respectively. The hazard indices associated with these pathways were not calculated since benzo(a)pyrene does not have available non-carcinogenic toxicity criteria. The potential cumulative risks for an excavation worker were $1x10^{-6}$, which is at the low end of USEPA's target risk range for health protectiveness.

The USEPA's Office of Solid Waste and Emergency Response directive states that, where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than $1x10^{-4}$, and the non-carcinogenic hazard index is less than 1, action is generally not warranted unless there could be adverse environmental effects. For conservative purposes, the assessment used the maximum detected iron concentration from one sample location in a groundwater grouping as the exposure point concentration, resulting in an overestimate of non-carcinogenic risk for hypothetical future site workers ingesting groundwater. In summary, potential risks associated with all areas and human exposure pathways evaluated in the assessment were at the low end of USEPA's target risk range for health protectiveness at CERCLA sites, and below levels that would generally warrant remedial action.

As outlined in Table 6-6, an attachment to the human health risk assessment evaluated potential risks to hypothetical, future site residents in the Northern Bush River Area. Section 7.1.3 presents conclusions regarding these risk calculations.

**Table 6-6. Summary of Risks Associated with Exposures in Northern Bush River Under Hypothetical Future Residential Land Use Conditions**

| Hypothetical Child Receptor/Pathway | Cancer Risk | Predominant Chemical | Non-Cancer Hazard Index | Predominant Chemical |
|---|---|---|---|---|
| **Cluster 7 Groundwater** | | | | |
| Ingestion | 9E-05 | Arsenic | **1.1E+01** | Iron |
| Dermal Absorption | 4E-06 | Beryllium | <1 (2E-01) | Manganese |
| Inhalation of VOCs | 2E-06 | Chloroform | NA | NA |
| **Cluster 35 Groundwater** | | | | |
| Ingestion | 6E-05 | Beryllium | **1.1E+01** | Iron |
| Dermal Absorption | 3E-05 | Heptachlor | <1 (2E-01) | Manganese |
| Inhalation of VOCs | 1E-06 | 1,1,2,2-Tetrachloroethane | NA | NA |
| **Cluster 36 Groundwater** | | | | |
| Ingestion | NA | NA | **1E+01** | Iron |
| Dermal Absorption | NA | NA | <1 (3E-02) | Iron |
| **Sediment (Boat Club Fill Sites)** | | | | |
| Incidental Ingestion | NA | NA | <1 (2E-02) | Thallium |
| Dermal Absorption | NA | NA | <1 (2E-03) | Thallium |
| **Surface Water (Site-wide Marsh Areas)** | | | | |
| Dermal Absorption | 1E-08 | 1,1,2,2-Tetrachloroethane | <1 (3E-04) | Chloroform |
| **Surface Water (Boat Club Fill Sites – Open Water Areas)** | | | | |
| Incidental Ingestion | 6E-08 | Beryllium | <1 (3E-05) | Beryllium |
| Dermal Absorption | 2E-06 | Beryllium | <1 (9E-04) | Beryllium |
| **Hypothetical Adult Receptor/Pathway** | **Cancer Risk** | **Predominant Chemical** | **Non-Cancer Hazard Index** | **Predominant Chemical** |
| **Cluster 7 Groundwater** | | | | |
| Ingestion | **2E-04** | Arsenic | **6E+00** | Iron |
| Dermal Absorption | 1E-05 | Beryllium | <1 (1E-01) | Manganese |
| Inhalation of VOCs | 2E-06 | Chloroform | NA | NA |
| **Cluster 35 Groundwater** | | | | |
| Ingestion | **1E-04** | Beryllium | **5E+00** | Iron |
| Dermal Absorption | 7E-05 | Heptachlor | <1 (9E-02) | Manganese |
| Inhalation of VOCs | 1E-06 | 1,1,2,2-Tetrachloroethane | NA | NA |
| **Cluster 36 Groundwater** | | | | |
| Ingestion | NA | NA | **5E+00** | Iron |
| Dermal Absorption | NA | NA | <1 (2E-02) | Iron |

NA Not applicable

Calculated cancer risk values at the high end of USEPA's target risk range for health protectiveness are indicated in **bold** text.
Indicating potential adverse effects could occur, calculated non-cancer hazard index values greater than 1 are shown in **bold** text.

## 6.2 Ecological Evaluation

The purpose of the screening-level ecological risk assessment is to assess the potential for adverse effects to non human (i.e., ecological) receptors resulting from exposure to chemicals in the Northern Bush River Area. The objective of the assessment was to identify chemicals having the potential to adversely effect ecological receptors, while eliminating other COPCs from further consideration. The screening-level ecological risk assessment is intended to allow rapid determination that either the Northern Bush River Area poses negligible ecological risk or specific contaminants and exposure pathways require further evaluation.

A separate methodology was used to select chemicals of ecological concern detected in surface soil, sediment, and surface water samples. The detected chemicals were not compared to RBCs because these values are only applicable to human exposure scenarios. The assessment did not use data qualified as blank contamination or rejected. Samples were first grouped based on environmental media, consideration of the on-site drainage patterns, and evaluation of potential chemical source areas, as follows: "On-site Surface Soil, North Shore of Cluster 35, Drainage Basin between Clusters 7 and 35, Boat Club Fill Sites, and Kings Creek Drainage." Ecological COPCs were then selected for evaluation if their maximum concentrations exceeded the screening-level concentrations for ecological receptors provided by USEPA Region III BTAG. These screening levels are based on chemical concentrations considered to be protective of the most sensitive organism in a medium. Screening-levels for some chemicals were available for both flora and fauna and, in such cases, the lower of the two values was used. Chemicals with maximum concentrations below the screening levels were eliminated from further consideration. All other chemicals were maintained as ecological COPCs, including those chemicals lacking screening levels. Based on an analysis of the ecological receptors present and the COPCs detected in the environmental media, the following assessment endpoints were selected for evaluation in the screening level ecological risk assessment:

- Exposure of terrestrial plants (as represented by herbaceous plant communities) from root uptake of chemicals in surface soil;
- Exposure of terrestrial soil invertebrate communities (as represented by earthworms) from dermal contact with and ingestion of chemicals in surface soil;
- Exposure of herbivorous mammals (as represented by the meadow vole) from the ingestion of chemicals in surface soil, surface water, and plant material;
- Exposure of vermivorous birds and small mammals (as represented by American robin and the short-tailed shrew, respectively) from the ingestion of chemicals in surface soil, surface water, and prey items (as represented by earthworms);

- Exposure of predatory birds and mammals (as represented by the red-tailed hawk and red fox, respectively) from the ingestion of chemicals in surface soil, surface water, and prey items (as represented by small mammals);
- Exposure of aquatic organisms from direct contact with, respiration of, and ingestion of chemicals in surface water; and
- Exposure of benthic organisms from direct contact with, respiration of, and ingestion of chemicals in sediment.

Consistent with USEPA guidance, the assessment used the maximum chemical concentrations detected in surface soil samples to evaluate the potential for chemicals to adversely effect terrestrial plants and soil invertebrates. Section 7.3.1.3 of the ecological risk assessment identifies the models and input parameters used to evaluate the potential for adverse effects to terrestrial wildlife from ingestion of chemicals in surface soil, surface water, and prey items. The assessment also used the maximum chemical concentrations detected in surface water and sediment to evaluate the potential for adverse effects to aquatic and benthic organisms, respectively. Data from each watershed were first compared to literature-based toxicity values. The ecological effects assessment then derived literature- or surrogate-based toxicity reference values to represent concentrations of the COPCs that are acceptably protective of the evaluated ecological receptors. The assessment next compared the derived potential exposure concentrations and doses with toxicity reference values to determine whether there is the potential for ecological receptors to be adversely effected by the COPCs in the Northern Bush River Area. Consistent with current guidance, chemicals having estimated exposure concentrations exceeding the toxicity reference values were further evaluated by additional factors to determine the need for further investigation. These additional factors include reference (background) levels, magnitude of contamination, spatial distribution of contaminants, exposure concentrations exceeding the Lowest Observed Adverse Effect Level, and the habitat quality.

The results of the screening ecological risk assessment indicate the potential for specific chemicals identified for evaluation to adversely effect aquatic and benthic organisms. No chemicals were identified as warranting further evaluation for the remaining receptor groups (i.e., terrestrial plants, soil invertebrates, herbivorous mammals, vermivorous birds and small mammals, and predatory birds and mammals). These results reflect to a great extent the conservative approach used in the screening assessment, the objective of which is to eliminate chemicals from further evaluation. The screening assessment does not definitively determine if chemicals are causing adverse effects to ecological receptors. The assessment should be referred to for a detailed evaluation of the screening-level ecological risk assessment results. Based on the evaluations made in the "Risk Evaluation and Management" section of the ecological risk

assessment for each receptor group identified for evaluation, the following conclusions are presented:

- *Aquatic Organisms* – The screening-level ecological risk assessment indicated the potential for adverse effects from the presence of total mercury detected at 1.4 µg/L in surface water sample C35-SW-04 located on the northeast shoreline of the drainage basin between Clusters 7 and 35 (Figure 4-2). Mercury could warrant further consideration in the surface water at this portion of the drainage basin because the maximum concentration exceeded the toxicity reference value and background level.
- *Benthic Organisms* – The screening-level ecological risk assessment indicated the potential for adverse effects from the presence of DDTr detected at (1) 432 µg/Kg in sediment sample C35-SD-02 located on the north shoreline of Cluster 35 and (2) 204 µg/Kg in sediment sample C07-SD-04 located on the eastern shoreline of the drainage basin between Clusters 7 and 35 (Figure 4-2). DDTr could warrant further consideration in the sediment at this portion of the drainage basin because the maximum concentrations of each compound exceeded the toxicity reference values.

It is important to note that while these chemicals were indicated by the screening-level ecological risk assessment as having the potential to adversely effect ecological receptors, this does not indicate the occurrence of adverse effects. The information can be used as part of a Scientific Management Decision Point, which follows the screening-level assessment, to help in interpreting the results of the assessment and making conclusions about the need for further evaluation or additional investigation.

## 6.3 Radiological Assessment

The radiological parameters detected in environmental media in the Northern Bush River Area were evaluated using a preliminary screening-level comparison of detected site concentrations to RBCs in accordance with USEPA guidance and discussions with the USEPA Region III health physicist. These RBCs were derived for residential and industrial receptors for exposure to soil and developed from a target risk level for cancer of $1x10^{-4}$. Isotope-specific analysis was performed only for Cluster 7 Boat Club Fill Sites' surface soil, subsurface soil, and sediment. Environmental media in the Cluster 35 DPW Storage Areas and Cluster 36 Warehouse Sites contained only gross alpha and gross beta concentrations. There is no method by which RBCs can be derived for gross alpha and gross beta measurements in other environmental media.

The comparison of maximum activities to RBCs resulted in identifying only one radionuclide, potassium-40, as a radionuclide of potential concern. Potassium-40's maximum activity of 45.9

pCi/g in surface soil sample C07-SS-04, 48.7 pCi/g in subsurface soil sample C07-SO-02, and 44.8 pCi/g in sediment sample C07-SD-01 exceeded the RBCs for both residential and industrial land use of 6.8 and 27.2 pCi/g, respectively. Potassium-40 was evaluated by a dose assessment using the computer model RESRAD™ version 5.61 and calculating standard USEPA cancer risk estimates.

Exposure to arithmetic mean activity levels of potassium-40 resulted in the following maximum total dose estimates: 10.1 millirem per year for exposure to surface soil, 17.2 millirem per year for exposure to subsurface soil, and 9.2 millirem per year for exposure to sediment. A USEPA-proposed maximum effective dose equivalent of 15 millirem per year for unrestricted residential use of a site was used as a benchmark level against which to compare the total dose estimates. The 17.2 millirem per year for exposure to subsurface soil exceeds this benchmark. Given the conservative nature of this analysis, this minimal amount that exceeds the benchmark level should not activate any additional analysis.

Since the maximum detected activities for all three environmental media were very similar, one set of estimated cancer risks for surface soil were calculated. Estimated cancer risks for ingestion of soil are $6x10^{-7}$ and those for external irradiation are $7x10^{-4}$, resulting in a cumulative risk of $7x10^{-4}$. External irradiation could be mitigated by many factors, including percentage of time spent outdoors, and the number and configuration of on-site buildings. Potassium-40 was carried through in the above estimated, even though potassium and potassium-40 are both naturally occurring in the Earth's crust and in the human body. Therefore, any contribution to dose from activity levels at Northern Bush River would be less than the amount in the human body and from naturally occurring levels.

# 7.0 SUMMARY AND CONCLUSIONS

This section summarizes site histories and descriptions in Section 1, the nature and extent of contamination in Section 4, contaminant fate and transport in Section 5, and the baseline human health and screening-level ecological risk assessments in Section 6. Conclusions are based on the information summarized and presented throughout the document. Recommendations for future work and remedial action objectives are based on the RI and risk assessment results.

## 7.1 Summary

Since the early 1930s, Northern Bush River has been used for general storage, chemical storage, and waste disposal under a military industrial land use setting. The U.S. Army primarily used the 230-acre area as a storage facility for different types of materials used in research, testing, and production operations in the Edgewood Area. Such materials included chemical agents (i.e., tear gas agents and materials for production use), general storage items, munitions, high explosives, and ammunition. Since the 1950s, portions of the area have been used for open storage of bulk construction-related materials (e.g., gravel, soil, crushed stone, and salvaged building supplies).

The Cluster 7 Boat Club Fill Sites consist of four separate locations labeled Sites 9A, 9B, 9C, and 9D (DSERTS # EABR07-A) where man-made filling activities occurred, and a former Bio-Sensor Research Facility (DSERTS # EABR07-B) existed, consisting of a former dog kennel and wastewater package treatment plant. Potentially contaminated fill materials in soil were placed in Site 9A and 9D during the early 1940s, and in Sites 9B and 9C in 1988. Operations at the former Bio-Sensor Research Facility began in the late 1960s and ceased in the 1970s.

The Cluster 35 DPW Storage Areas consist of three separate locations labeled Gravel and Soil Storage Sites 22A, 22B, and 22C (DSERTS # EABR35-A), and Buildings E2144, E2148, and E2150 (DSERTS # EABR35-B). Aerial photographs from 1951 displayed unidentified stored materials at Storage Sites 22A and 22B, where gravel and salvaged construction materials are placed today. Parts of these sites were located within a former fenced and secured storage area. A soil dirt pile containing low concentrations (less than 46 µg/Kg) of three SVOCs and DDTr, and TCLP and TPH at concentrations below RCRA regulatory criteria, has been stored at Storage Site 22C since 1989.

The Cluster 36 Warehouse Sites contain nine Warehouse Storage Areas (DSERTS # EABR36-A), the Building 846 (E2194) Waste Disposal Site (DSERTS # EABR36-B), a former Drummed Soil Road Barricade Site during 1986 and 1987, the Boat Club Ship Store (Building E2169) and associated septic tank, and DPW Southwest Storage Areas (DSERTS # EABR36-A). The

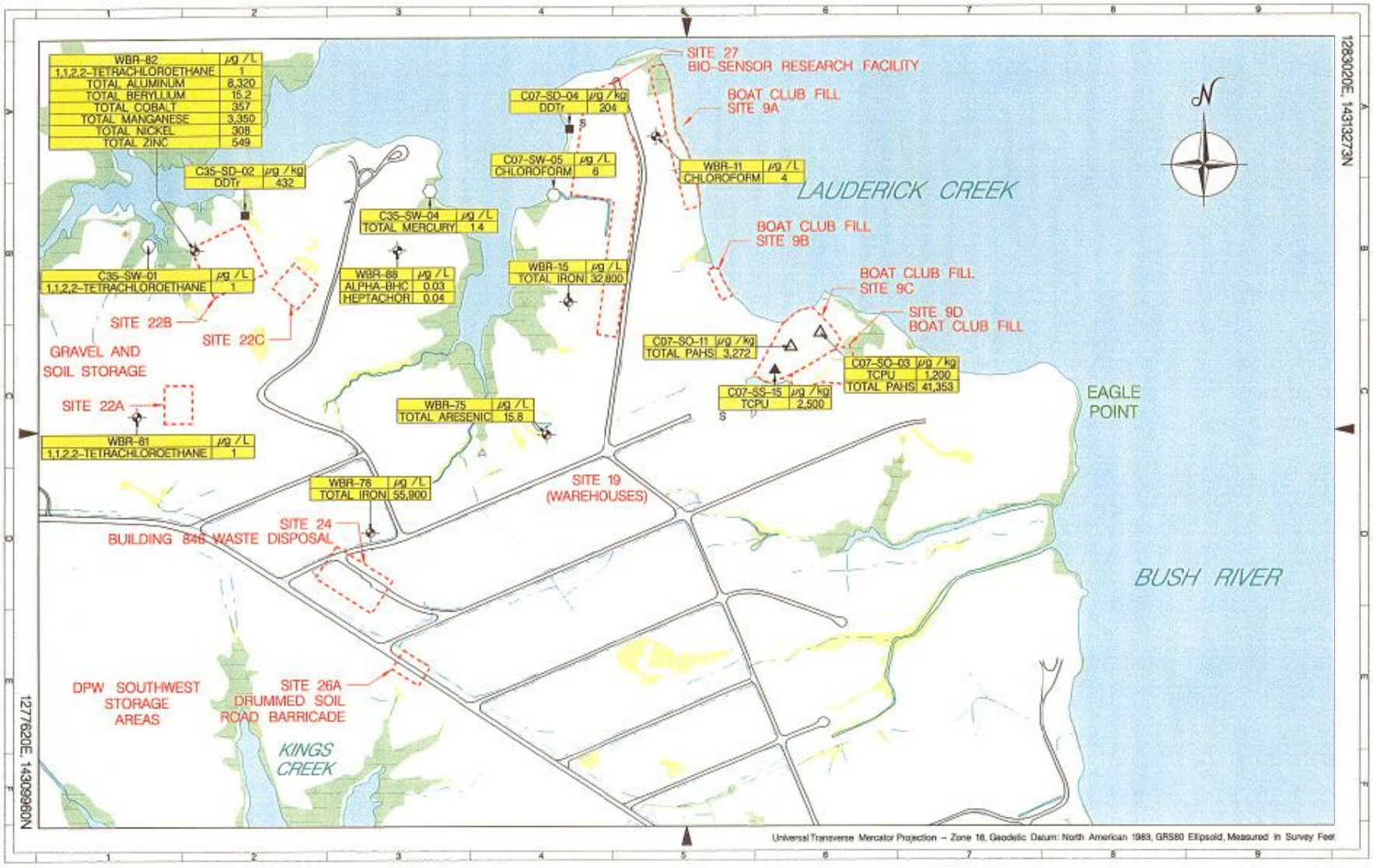
warehouses were built for material and munitions storage in the early 1940s. A man-made fill site less than a half-acre in size lies north of warehouse E2168. Construction work in the 1980s and in 1999 uncovered the burned remains of gas masks, filters, and contaminated soil north of building E2194, and north of an entrance gate to the current secured storage area. The burned materials and soil were removed and properly disposed of to complete the construction activities (USAEHA, 1989; Roy F Weston, Inc., 2000).

DSHE developed three Detailed RI Work Plans and one Addenda involving characterization of Northern Bush River sites by reviewing historical documents, aerial photographs, and documentation of previous investigations of the area. Surface feature investigations identified potential contaminant sources, physical characteristics, and environmental media sampling locations. Soil gas surveys attempted to identify VOC contamination in the vadose zone and determine optimal placement of selected environmental media sampling locations. Stratigraphic sampling of geotechnical borings and monitoring well locations outlined the regional and localized subsurface geology and hydrogeology. Surficial aquifer groundwater flow directions, hydraulic properties, and recharge/discharge areas were defined by potentiometric surface maps of groundwater level measurements, slug testing of wells, vadose zone interpretations, and a thermal imagery map. Environmental media sampling and analyses for groundwater, surface water, sediment, surface soil, subsurface soil, and sludge water during the RI identified contaminants present at the sites in Northern Bush River.

Removal actions of burned gas mask remnants and contaminated soil north of an entrance gate to the secured storage area in 1999, potentially contaminated surface waste material throughout the Bush River Study Area in 1996, and munitions on the Lauderick Creek shoreline in 1995 have eliminated the known wastes and removed materials at these sites as contaminant source areas.

### 7.1.1 Nature and Extent of Contamination

Sampling and analysis results indicate localized or limited environmental contamination at sites associated with the Cluster 7 Boat Club Fill Sites, Cluster 35 DPW Storage Areas, and Cluster 36 Warehouse Sites. No PCBs, explosive-related compounds, or chemical agent degradation products were detected in Northern Bush River environmental media. There is no correlation of contaminants between the sample locations, indicating the detections are sporadic and isolated. Figure 7-1 displays the major contaminant concentrations in Northern Bush River environmental media based on comparisons to established, risk-based screening criteria and background levels.




## L E G E N D

- Water
- Tidal Wetland
- Non-tidal Wetland
- Road
- Stream / Drainage Ditch
- Site Boundary
- Monitoring Well
- Subsurface Soil Sample
- Surface Water Sample
- Septic Tank Sample
- Surface Soil Sample
- Sediment Sample

600 400 200 0 300 600 1200

GRAPHICAL SCALE
IN FEET (1" = 600')

# NORTHERN BUSH RIVER CONTAMINANT CONCENTRATIONS

6095 Marshalee Drive
Elkridge, MD 21075
(800) 727-6677
www.gpworldwide.com

| CARTOGRAPHER: | APPROVED BY: | DATE: | FIGURE: |
|---|---|---|---|
| B. JOYCE | T. DEREAMER | 01-23-03 | 7-1 |

I:\Edgewood Graphics\GEOGRAPHICS\Bush River\Northern Bush River\nbrcontam_RI.dgn

Within the Cluster 7 Boat Club Fill Site 9C, surface and subsurface soil contains the most amount of impacts from TCPU as high as 2,500 µg/Kg, and total PAHs as high as 41,353 µg/Kg. During both sampling rounds, the highest concentrations of chloroform occurred in surface water sample C07-SW-05 at 6 µg/L and groundwater from well WBR-11 at 4 µg/L. DDTr was detected at 204 µg/Kg in sediment sample location C07-SD-04. During both sampling rounds, the highest concentrations of total iron occurred at well WBR-15 as high as 32,800 µg/L. Concentrations of total silver and zinc were detected above surface water background and ecological risk screening levels in the sludge water sample from the chlorine contact chamber of the wastewater package treatment plant for the former Bio-Sensor Research Facility. This unused, septic system lies immediately adjacent to the Lauderick Creek shoreline. Downgradient sediment sample C07-SD-04 also contained detections of silver above background and ecological risk screening levels, and zinc above background limits.

Within the Cluster 35 Storage Site 22B, concentrations of total metals were detected above background levels during both rounds of groundwater sampling from well WBR-82. Under separate sampling events and during one round, 1,1,2,2-tetrachloroethane was detected at 1 µg/L in groundwater from wells WBR-81 and -82, and in surface water at C35-SW-01. First round groundwater samples from well WBR-88 contained alpha-BHC at 0.03 µg/L and heptachlor at 0.04 µg/L. DDTr was detected at 432 µg/Kg in sediment sample C35-SD-02 located in a marsh downgradient of Storage Site 22B. Total mercury was detected at 1.4 µg/L in the second round of sampling at location C35-SW-04, downgradient from a drainage swale northeast of building E2144.

Within the Cluster 36 Warehouse Sites, detected pesticides in environmental media are likely the result of past insect control in the area. During both sampling rounds of groundwater, concentrations of total iron occurred at well WBR-78 as high as 55,900 µg/L, and concentrations of total arsenic occurred at well WBR-75 as high as 15.8 µg/L. Concentrations of total cadmium, chromium, copper, lead, mercury, zinc, and cyanide were detected above surface water background limits and ecological risk screening levels in the sludge water sample from the septic tank associated with building E2169. This unused, septic tank lies within a steep drainage ditch leading to wetland area.

### 7.1.2 Contaminant Fate and Transport

The primary route of migration for the Northern Bush River Area is contaminant release in the soil, infiltration of the contaminant through the vadose zone to the surficial aquifer groundwater, and subsequent groundwater migration. Groundwater within the surficial aquifer moves from the middle of the peninsula and splits to flow to the north and northeast toward Lauderick Creek, and southwest toward Kings Creek. Groundwater then discharges into the marsh areas and surface

water associated with the tributaries of Lauderick Creek and Kings Creek. The secondary route of migration is water runoff and sediment erosion and transport from contaminated surface soil into nearby marsh areas and surface water bodies. Surface water drainage is to Lauderick Creek and Kings Creek. Sediment particles can be suspended in surface water for further transport or deposition in the creeks or the Bush River sediment.

For the Cluster 7 Boat Club Fill Sites, the major sources of contamination occur at Fill Site 9C located under a graveled parking lot. The military clothing impregnate degradation product TCPU and PAHs were detected within the subsurface soil fill material. One out of six surface soil samples contained TCPU. Environmental media samples associated with the Bio-Sensor Research Facility and the remaining Boat Club Fill Sites 9A, 9B, and 9C contained isolated detections of organic compounds (e.g., choroform, DDTr, other pesticides) and inorganic compounds, such as iron in groundwater. Due to the tendency of TCPU, PAHs, DDTr, and metals to adsorb to soil, these compounds will probably persist in localized areas. High-molecular-weight PAHs can absorb to soil, and soil particles can be transported north/northeast from stormwater runoff to Lauderick Creek. Low-molecular-weight PAHs are more likely to volatilize or biodegrade. No significant migration of contaminants is expected to occur. The wastewater package treatment plant associated with the former Bio-Sensor Research Facility serves as a potential source of contamination.

For the Cluster 35 DPW Storage Areas, the major sources of contamination occur at the Storage Site 22B, and near Buildings E2144, E2148, and E2150. Sustained concentrations of total metals, including aluminum, beryllium, cobalt, manganese, nickel, and zinc, occurred in well WBR-82 within Storage Site 22B. Concentrations of 1,1,2,2-tetrachloroethane, pesticides, and mercury in surface water, and DDTr and metals in sediment and soil occurred at a few localized sampling locations. No significant migration of contaminants is expected to occur.

For the Cluster 36 Warehouse Storage Areas, the primary sources of contamination occur from arsenic detected in groundwater from wells WBR-75 and –78. The Warehouse Storage Areas, Building 846 (E2194) Waste Disposal Site, and the DPW Southwest Storage Areas contained low concentrations of DDTr and metals in environmental media. No significant migration of contaminants is expected to occur. The septic tank associated with building E2169 serves as a potential source of contamination.

### 7.1.3 Baseline Risk Assessment

The estimated upper bound excess lifetime cancer risks for the Northern Bush River Area were compared to USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ for health protectiveness at CERCLA sites. The estimated non-carcinogenic hazard indices were compared to 1; values greater than 1

indicate a potential for adverse health effects. The following results present the potential cancer risks and non-carcinogenic hazard indices for each receptor quantitatively evaluated in the human health risk assessment.

Under current land use conditions, the excess lifetime cancer risk to trespasser exposures from dermal absorption of chemicals in surface water while wading at "Site-wide Marsh Areas" totaled $2x10^{-8}$, and the hazard index was less than 1. Cumulative risk estimates were not calculated since trespassers were each assumed to be exposed to chemicals in surface water from only one pathway, dermal absorption.

Under current land use conditions, the excess lifetime cancer risk to youth visitor exposures from incidental ingestion and dermal absorption of thallium in sediment at the "Boat Club Fill Sites" were not calculated since thallium does not have available carcinogenic toxicity criteria. The hazard indices were less than 1. The excess lifetime cancer risks to youth visitor exposures from incidental ingestion and dermal absorption of chemicals in surface water while swimming at the "Boat Club Fill Sites - Open Water Areas" were $6x10^{-8}$ and $3x10^{-6}$, respectively. The hazard indices were both less than 1. The potential cumulative risk for youth visitors was $3x10^{-6}$, which is at the low end of USEPA's target risk range for health protectiveness. The cumulative hazard index was less than 1, indicating that adverse effects would most likely not occur.

Under future land use conditions, potential risks to hypothetical, future site workers from ingestion of chemicals in groundwater in all three groundwater data groupings were quantified. Cumulative risk estimates were not calculated since site workers were each assumed to be exposed to chemicals in groundwater from only one pathway, ingestion.

The excess lifetime cancer risk to future site workers from ingestion of the Cluster 7 groundwater grouping totaled $6x10^{-5}$, and was primarily associated with exposures to arsenic. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 1 for iron, which is not associated with a specific target organ.

The excess lifetime cancer risk to future site workers from ingestion of the Cluster 35 groundwater grouping totaled $4x10^{-5}$, and was primarily associated with exposures to beryllium. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 1 for iron, which is not associated with a specific target organ.

indicate a potential for adverse health effects. The following results present the potential cancer risks and non-carcinogenic hazard indices for each receptor quantitatively evaluated in the human health risk assessment.

Under current land use conditions, the excess lifetime cancer risk to trespasser exposures from dermal absorption of chemicals in surface water while wading at "Site-wide Marsh Areas" totaled $2x10^{-8}$, and the hazard index was less than 1. Cumulative risk estimates were not calculated since trespassers were each assumed to be exposed to chemicals in surface water from only one pathway, dermal absorption.

Under current land use conditions, the excess lifetime cancer risk to youth visitor exposures from incidental ingestion and dermal absorption of thallium in sediment at the "Boat Club Fill Sites" were not calculated since thallium does not have available carcinogenic toxicity criteria. The hazard indices were less than 1. The excess lifetime cancer risks to youth visitor exposures from incidental ingestion and dermal absorption of chemicals in surface water while swimming at the "Boat Club Fill Sites - Open Water Areas" were $6x10^{-8}$ and $3x10^{-6}$, respectively. The hazard indices were both less than 1. The potential cumulative risk for youth visitors was $3x10^{-6}$, which is at the low end of USEPA's target risk range for health protectiveness. The cumulative hazard index was less than 1, indicating that adverse effects would most likely not occur.

Under future land use conditions, potential risks to hypothetical, future site workers from ingestion of chemicals in groundwater in all three groundwater data groupings were quantified. Cumulative risk estimates were not calculated since site workers were each assumed to be exposed to chemicals in groundwater from only one pathway, ingestion.

The excess lifetime cancer risk to future site workers from ingestion of the Cluster 7 groundwater grouping totaled $6x10^{-5}$, and was primarily associated with exposures to arsenic. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 1 for iron, which is not associated with a specific target organ.

The excess lifetime cancer risk to future site workers from ingestion of the Cluster 35 groundwater grouping totaled $4x10^{-5}$, and was primarily associated with exposures to beryllium. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 1 for iron, which is not associated with a specific target organ.

The excess lifetime cancer risk to future site workers from ingestion of the Cluster 36 groundwater grouping was not calculated since none of the selected COPCs have available carcinogenic toxicity criteria. The hazard index associated with non-carcinogenic chemicals was equal to 2 and, therefore, was recalculated by target organ or critical effect. When recalculated, the hazard index was equal to 2 for iron, which is not associated with a specific target organ.

Under future land use conditions, potential risks to future excavation workers were quantified. The excess lifetime cancer risks to excavation worker exposures from incidental ingestion and dermal absorption of benzo(a)pyrene in subsurface soil were $6x10^{-7}$ and $4x10^{-7}$, respectively. The hazard indices associated with these pathways were not calculated since benzo(a)pyrene does not have available non-carcinogenic toxicity criteria. The potential cumulative risks for an excavation worker were $1x10^{-6}$, which is at the low end of USEPA's target risk range for health protectiveness.

The USEPA's Office of Solid Waste and Emergency Response directive states that, where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than $1x10^{-4}$, and the non-carcinogenic hazard index is less than 1, action is generally not warranted unless there could be adverse environmental effects. For conservative purposes, the assessment used the maximum detected iron concentration from one sample location in a groundwater grouping as the exposure point concentration, resulting in an overestimate of non-carcinogenic risk for hypothetical, future site workers ingesting groundwater. In summary, the potential risks associated with all areas and human exposure pathways evaluated in the assessment were at the low end of USEPA's target risk range for health protectiveness at CERCLA sites, and below levels that would generally warrant remedial action.

Table 6-6 in Section 6.1.3 summarized risks associated with exposures in Northern Bush River under hypothetical, future residential land use conditions. Future residents could contact surface soil; however, no COPCs with available toxicity criteria were selected in the surface soil data groupings. Therefore, the probability of contracting cancer from surface soil exposures would be less than one in one million, and adverse non-carcinogenic effects would not be expected to occur. Under hypothetical, residential land use conditions, potential cancer risks to child residents from exposures to surface water and sediment would be within USEPA's acceptable risk range for health protectiveness, and adverse non-carcinogenic effects would not be expected to occur. The excess lifetime cancer risks to hypothetical, future child residents from exposures to groundwater were within USEPA's acceptable risk range. Hazard indices were above 10 for potential non-carcinogenic risks to hypothetical, future child residents from exposures to groundwater. The excess lifetime cancer risks to hypothetical, future adult residents from ingestion of groundwater were at the high end of USEPA's acceptable risk range. Hazard indices were above 5 for potential non-carcinogenic risks to hypothetical, future adult residents from

ingestion of groundwater. For conservative purposes, the attachment used the maximum detected arsenic, beryllium, and iron concentrations from one sample location in a groundwater grouping as the exposure point concentration, resulting in an overestimate of risk for hypothetical, future resident exposures to groundwater. In summary, the potential risks associated with hypothetical, future resident exposure pathways presented in the attachment were at the low end of USEPA's target risk range for health protectiveness at CERCLA sites, and below levels that would generally warrant remedial action.

The results of the screening-level ecological risk assessment indicate the potential for specific chemicals identified for evaluation to adversely effect aquatic and benthic organisms. No chemicals were identified as warranting further evaluation for the remaining receptor groups (i.e., terrestrial plants, soil invertebrates, herbivorous mammals, vermivorous birds and small mammals, and predatory birds and mammals).

## 7.2 Data Limitations and Recommendations

The screening-level ecological risk assessment recommended further investigation of mercury in surface water at location C35-SW-04, located on the northeast shoreline of the drainage basin between Clusters 7 and 35; and DDTr in sediment at locations C35-SD-02, located on the north shoreline of Cluster 35, and C07-SD-04, located on the eastern shoreline of the drainage basin between Clusters 7 and 35. Subsequent sampling in 2000 did not find elevated concentrations of mercury in surface water and sediment, and DDTr in sediment. Table 7-1 displays the sample results for mercury compared to BTAG screening levels and maximum reference (background) values. Table 7-2 displays the sample results for DDTr compared to BTAG screening levels and maximum reference (background) values.

The Ecological Risk Assessment for the Northern Bush River Area identified surface water sampling location C35-SW-04 for further investigation because a total mercury concentration exceeded the ecological risk screening level, and there is a potential for mercury to adversely effect aquatic organisms (IT Corporation, 2000, p. 7-41). Re-sampling occurred at location C35-SW/SD-04 on December 21, 2000 for total and dissolved (filtered) mercury in surface water and total mercury in sediment. This effort did not confirm the presence of an elevated total mercury concentration in surface water detected during Round 2. The total mercury concentration detected at 0.13 µg/L during Round 3 was below the maximum reference (background) values. Dissolved mercury has not been detected in any of the three sampling rounds.

**Table 7-1. Northern Bush River Mercury Results Compared to Ecological Risk Screening Levels and Maximum Reference Values**

| Sample ID | Compound | Concentration (µg/L) | BTAG Screening Level (µg/L) | Above BTAG Screening Level? | Maximum Reference Value (µg/L) | Above Maximum Reference Value? |
|---|---|---|---|---|---|---|
| C35-SW-04 Round 1 | Mercury, Total | ND | 0.012 | NO | 0.2 | NO |
| | Mercury, Dissolved | ND | 0.012 | NO | 0.2 | NO |
| C35-SW-04 Round 2 | Mercury, Total | 1.40 | 0.012 | YES | 0.2 | YES |
| | Mercury, Dissolved | ND | 0.012 | NO | 0.2 | NO |
| C35-SW-04 Round 3 | Mercury, Total | 0.13 | 0.012 | YES | 0.2 | NO |
| | Mercury, Dissolved | ND | 0.012 | NO | 0.2 | NO |
| C35-SD-04 Round 1 | Mercury, Total | 0.050 | 0.15 | NO | 0.398 | NO |
| C35-SD-04 Round 2 | Mercury, Total | 0.064 | 0.15 | NO | 0.398 | NO |

ID identification
ND non-detected
BTAG U.S. Environmental Protection Agency Region III Biological Technical Assistance Group

**Table 7-2. Northern Bush River DDTr Results Compared to Ecological Risk Screening Levels and Maximum Reference Values**

| Sample ID | Compound | Concentration (µg/Kg) | BTAG Screening Level (µg/Kg) | Above BTAG Screening Level? | Maximum Reference Value (µg/Kg) | Above Maximum Reference Value? |
|---|---|---|---|---|---|---|
| C35-SD-02 Round 1 | 4,4'-DDD | 268.0 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 144.0 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | 20.0 | 1.58 | YES | 15.4 | YES |
| | **DDTr** | **432.0** | | | | |
| C35-SD-02A | 4,4'-DDD | 64.0 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 39.0 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | ND | 1.58 | NO | 15.4 | NO |
| | **DDTr** | **103.0** | | | | |
| C35-SD-02B | 4,4'-DDD | 27.0 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 16.0 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | 9.8 | 1.58 | YES | 15.4 | NO |
| | **DDTr** | **52.8** | | | | |
| C35-SD-02C | 4,4'-DDD | 73.0 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 39.0 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | 8.6 | 1.58 | YES | 15.4 | NO |
| | **DDTr** | **120.6** | | | | |
| C35-SD-02D | 4,4'-DDD | 15.0 | 16.00 | NO | 8.3 | YES |
| | 4,4'-DDE | 11.0 | 2.20 | YES | 11.0 | NO |
| | 4,4'-DDT | ND | 1.58 | NO | 15.4 | NO |
| | **DDTr** | **26.0** | | | | |
| C07-SD-04 Round 1 | 4,4'-DDD | 160 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 44 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | ND | 1.58 | NO | 15.4 | NO |
| | **DDTr** | **204** | | | | |
| C07-SD-04A | 4,4'-DDD | 1,450 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 570 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | 105 | 1.58 | YES | 15.4 | YES |
| | **DDTr** | **2,125** | | | | |
| C07-SD-04B | 4,4'-DDD | 8 | 16.00 | NO | 8.3 | NO |
| | 4,4'-DDE | 6 | 2.20 | YES | 11.0 | NO |
| | 4,4'-DDT | ND | 1.58 | NO | 15.4 | NO |
| | **DDTr** | **14** | | | | |
| C07-SD-04C | 4,4'-DDD | 110 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 54 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | 31 | 1.58 | YES | 15.4 | YES |
| | **DDTr** | **195** | | | | |
| C07-SD-04D | 4,4'-DDD | 58 | 16.00 | YES | 8.3 | YES |
| | 4,4'-DDE | 39 | 2.20 | YES | 11.0 | YES |
| | 4,4'-DDT | 6 | 1.58 | YES | 15.4 | NO |
| | **DDTr** | **103** | | | | |

ID identification
ND non-detected
BTAG U.S. Environmental Protection Agency Region III Biological Technical Assistance Group
DDTr Sum of the pesticide 4,4'-DDT and its degradation compounds 4,4'-DDE and 4,4'-DDD

Both sediment sampling rounds had total mercury concentrations below screening levels and background values. The mercury concentrations are not sustained and not associated with an identified source area. Therefore, no further investigation of mercury is recommended at this location.

The Ecological Risk Assessment for the Northern Bush River Area identified sediment sampling locations C35-SD-02 and C07-SD-04 for further investigation because 4,4'-DDD and 4,4'-DDE concentrations exceeded the ecological risk screening levels, and there is a potential for DDTr to adversely effect benthic organisms (IT Corporation., 2000, pp. 7-37 and 7-38). Re-sampling occurred at locations C35-SD-02 and C07-SD-04 on December 12, 2000 for DDTr from four points spaced approximately 4-feet from one another in a diamond pattern around each of the original sampling locations. With the exception of one sample point (i.e., C07-SD-04A), this effort showed DDTr concentrations to be lower, with the maximum levels to be 121 µg/Kg at C35-SD-02 and 195 µg/Kg at C07-SD-04. Near location C35-SD-02, 4,4'-DDD ranged from 15 to 73 µg/Kg, 4,4'-DDE ranged from 11 to 39 µg/Kg, and 4,4'-DDT ranged from non-detected to 9.8 µg/Kg. Near location C07-SD-04, 4,4'-DDD ranged from 8 to 1,450 µg/Kg, 4,4'-DDE ranged from 6 to 570 µg/Kg, and 4,4'-DDT ranged from non-detected to 105 µg/Kg. The final degradation product 4,4'-DDD has been consistently detected at higher concentrations than 4,4'-DDE and 4,4'-DDT. These concentrations suggest historical use of 4,4'-DDT for mosquito control activities, rather than from waste disposal. The DDTr concentrations appear localized and are not associated with an identified source area. Therefore, no further investigation of DDTr is recommended at either location.

The possible presence of buried UXO and chemical warfare material within the Northern Bush River Area cannot be eliminated based on known historical testing and recent removal of UXO items and remnants. The U.S. Army has posted signs informing potential trespassers of the dangers present on site. Additionally, random patrols by military police and other law enforcement officials reduce the likelihood of trespassers.

### 7.3 Recommended Remedial Action Objectives

Sufficient data have been collected to complete the Northern Bush River RI and risk assessment. Environmental media sampling and analyses for groundwater, surface water, sediment, surface soil, subsurface soil, and sludge water identified localized and limited environmental impacts. The human health risk assessment indicated that further action is generally not warranted unless there could be adverse environmental effects. As recommended by the screening-level ecological risk assessment, further investigation occurred of mercury in surface water at location C35-SW-04, located on the northeast shoreline of the drainage basin between Clusters 7 and 35; and DDTr in

sediment at locations C35-SD-02, located on the north shoreline of Cluster 35, and C07-SD-04, located on the eastern shoreline of the drainage basin between Clusters 7 and 35. Subsequent sampling in 2000 did not find elevated concentrations of mercury in surface water and sediment, and DDTr in sediment. Therefore, no further investigation of these compounds is recommended.

Both the chlorine contact chamber of the wastewater package treatment plant associated with the former Cluster 7 Bio-Sensor Research Facility and the septic tank associated with the Cluster 36 building E2169 serve as a potential source of contamination. Removal of the metal-contaminated water (exceeding background and ecological risk screening levels) in the septic tank systems and abandonment with flowable, concrete fill are recommended to prevent environmental release.

Table 7-3 presents the Northern Bush River groundwater groupings and recommended remedial action objectives concerning groundwater based on the human health risk assessment results.

Table 7-4 presents the recommended future actions for each site based on the RI and risk assessment results. These recommendations do not address the potential hazards due to the possible presence of UXO and chemical warfare material, or potential land use controls in a future Record of Decision.

## Table 7-3. Northern Bush River Groundwater Groupings and Recommended Remedial Action Objectives

| Groundwater Sample Grouping | Associated Groundwater Monitoring Wells | Cancer Risk | Predominant Chemicals (a) | Non-cancer Hazard Index | Predominant Chemicals (a) | Recommended Remedial Action Objectives |
|---|---|---|---|---|---|---|
| **Hypothetical, Future Site Worker Ingestion of Groundwater** | | | | | | |
| Cluster 7 | WBR-11, -12, -13, -15, -74, and -75 | $6\times10^{-5}$ | Arsenic | 2 | Iron (c) | No further action |
| Cluster 35 | WBR-76, -81, -82, -83, -84, -86, -87, -88, -70, and -80 | $4\times10^{-5}$ | Beryllium | 2 | Iron (c) | No further action |
| Cluster 36 | WBR-77, -78, and -79 | --- | --- | 2 | Iron (c) | No further action |
| **Hypothetical, Future Child Resident Ingestion of Groundwater** | | | | | | |
| Cluster 7 | As above | $9\times10^{-5}$ | Arsenic | 11 | Iron (c) | No further action |
| Cluster 35 | As above | $6\times10^{-5}$ | Beryllium | 11 | Iron (c) | No further action |
| Cluster 36 | As above | --- | --- | 10 | Iron (c) | No further action |
| **Hypothetical, Future Adult Resident Ingestion of Groundwater** | | | | | | |
| Cluster 7 | As above | $2\times10^{-4}$ | Arsenic (b) | 6 | Iron (c) | No further action |
| Cluster 35 | As above | $1\times10^{-4}$ | Beryllium (b) | 5 | Iron (c) | No further action |
| Cluster 36 | As above | --- | --- | 5 | Iron (c) | No further action |

(a) Predominant chemicals were associated with a cancer risk greater than $1\times10^{-6}$ or a hazard index greater than 1.

(b) The arithmetic mean concentrations for total arsenic in Cluster 7 (4.08 µg/L) and for total beryllium in Cluster 35 (1.86 µg/L) were within reference (background) ranges (maximum of 11 and 8.3 µg/L, respectively). Arsenic and beryllium concentrations in Northern Bush River groundwater are considered to be within background ranges when all the concentrations are grouped together to determine the arithmetic mean.

(c) The arithmetic mean concentrations for total iron in Cluster 7 (15,200 µg/L) and Cluster 35 (6,760 µg/L) were within reference (background) ranges (maximum of 29,700 µg/L). The arithmetic mean concentration for total iron in Cluster 36 was 36,600 µg/L. There are no specific target organs associated with iron. Iron concentrations in Northern Bush River groundwater are considered to be within background ranges when all the concentrations are grouped together to determine the arithmetic mean.

Source: *Baseline Risk Assessment for the Northern Bush River Area, Aberdeen Proving Ground, Maryland* (ICF Kaiser Engineers, Inc., 1997)

## Table 7-4. Northern Bush River Sites and Recommended Future Actions

| Site Name | RFA Site No. | DSERTS No. | Recommended Future Actions |
|---|---|---|---|
| **Cluster 7 Boat Club Fill Sites** | | | |
| Boat Club Fill Sites | Sites 9A, 9B, 9C, and 9D | EABR07-A | No further action |
| Bio-Sensor Research Facility | Site 27 | EABR07-B | No further action |
| **Cluster 35 DPW Storage Areas** | | | |
| Gravel and Soil Storage | Sites 22A, 22B, and 22C | EABR35-A | No further action |
| Buildings E2194, E2148, and E2150 | Unnumbered | EABR35-B | No further action |
| **Cluster 36 Warehouse Sites** | | | |
| Warehouse Storage Areas | Site 19 | EABR36-A | No further action |
| Building 846 (E2194) Waste Disposal Site | Site 24 | EABR36-B | No further action |
| Drummed Soil Road Barricade Site | Site 26A | EABR36-A | No further action |
| Boat Club Ship Store | Unnumbered | EABR36-A | No further action |
| DPW Southwest Storage Areas | Unnumbered | EABR36-A | No further action |

Listed RCRA Facility Assessment (RFA) site names and numbers were designated in the Generic Work Plan and associated Detailed Remedial Investigation Work Plans.

DSERTS - Defense Site Environmental Restoration Tracking System
DPW - Directorate of Public Works

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| CONSTITUENTS | Units | Reference Background | RBC TAP | WBR-11 RD 1 29-May-96 | WBR-11 RD 2 27-Aug-96 | WBR-12 RD 1 29-May-96 |
|---|---|---|---|---|---|---|
| **Inorganics (Total)** | | | | | | |
| Aluminum | µg/L | 4,370 | 37,000 | 19.8 U | 37.5 K | 19.8 U |
| Antimony | µg/L | 1.5 | 15 | 2.3 U | 11 UL | 2.3 U |
| Arsenic | µg/L | 11 | 0.045 | 2 U | 4.1 UL | 37 B |
| Barium | µg/L | 132 | 2,600 | 16.1 B | 17.4 B | 13 B |
| Beryllium | µg/L | 8.3 | 73 | 0.3 U | 0.31 L | 0.3 U |
| Boron | µg/L | | 3,300 | 249 | 228 K | 470 |
| Cadmium | µg/L | 66.1 | 18 | 0.4 U | 0.0005 U | 0.4 U |
| Calcium | µg/L | 41,100 | | 5,540 K | 5,110 K | 3,190 K |
| Chromium | µg/L | 5 | 110 | 0.6 U | 4.8 UL | 0.6 U |
| Cobalt | µg/L | 29 | 730 | 5.1 B | 5.3 B | 9.9 B |
| Copper | µg/L | 241 | 1,500 | 6 B | 3 UL | 5 B |
| Iron | µg/L | 29,700 | 11,000 | 1,220 | 1,350 | 21,400 |
| Lead | µg/L | 436 | 15 | 1.2 B | 2.3 UL | 4.3 B |
| Manganese | µg/L | 866 | 730 | 93.4 | 85.1 | 261 |
| Magnesium | µg/L | 34,000 | | 3,990 K | 3,940 K | 2,820 K |
| Nickel | µg/L | 93 | 730 | 65 | 12 UL | 7.4 |
| Potassium | µg/L | 12,200 | | 444 | 430 L | 628 |
| Selenium | µg/L | 6.25 | 180 | 1.8 U | 3.4 UL | 1.8 U |
| Silver | µg/L | 0.15 | 180 | 0.7 U | 2.8 UL | 0.7 U |
| Sodium | µg/L | 177,000 | | 17,400 | 17,000 | 12,600 |
| Thallium | µg/L | 2.6 | 260 | 1.8 U | 1.8 U | 1.8 U |
| Vanadium | µg/L | 5 | 11,000 | 0.7 U | 2.4 UL | 0.75 |
| Zinc | µg/L | 476 | 11,000 | 17.3 B | 12.9 B | 14.1 B |
| Phosphorus (total) | µg/L | | | 662 UJ | 102 U | 646 UJ |
| **Pesticides/PCBs** | | | | | | |
| alpha-BHC | µg/L | | 0.011 | 0.05 U | 0.05 U | 0.05 U |
| alpha-Chlordane | µg/L | | 0.19 | 0.05 U | 0.05 U | 0.05 U |
| DDE | µg/L | | 0.2 | 0.1 U | 0.1 U | 0.1 U |
| DDT | µg/L | | 0.2 | 0.1 U | 0.1 U | 0.1 U |
| Endosulfan I | µg/L | | 220 | 0.05 U | 0.05 U | 0.05 U |
| Endosulfan II | µg/L | | 220 | 0.1 U | 0.1 U | 0.1 U |
| Endosulfan sulfate | µg/L | | | 0.1 U | 0.1 U | 0.1 U |
| Endrin aldehyde | µg/L | | 11 | 0.1 U | 0.1 U | 0.1 U |
| Heptachlor | µg/L | | 0.015 | 0.018 J | 0.05 U | 0.05 U |
| Heptachlor epoxide | µg/L | | 0.0074 | 0.05 U | 0.05 U | 0.05 U |
| **Phthalates** | | | | | | |
| Butylbenzyl phthalate | µg/L | | | 10 U | 10 U | 10 U |
| Bis(2-ethylhexyl)phthalate | µg/L | | 4.8 | 10 U | 10 U | 1 B |
| Dimethylphthalate | µg/L | | 370,000 | 10 U | 10 U | 10 U |
| Diethyl phthalate | µg/L | | 29,000 | 10 U | 10 U | 10 U |
| Di-n-butyl phthalate | µg/L | | 3,700 | 10 U | 1 J | 10 U |
| **Chlorinated Volatiles** | | | | | | |
| 1,1,2,2-Tetrachloroethane | µg/L | | 0.053 | 10 U | 10 U | 10 U |
| Chloroform | µg/L | | 0.152 | 4 J | 4 J | 10 U |
| Methylene Chloride | µg/L | | 4.1 | 3 J | 5 B | 6 B |
| Chloromethane | µg/L | | 2.11 | 8 B | 10 U | 10 U |
| **Misc Volatiles & Semivolatiles** | | | | | | |
| Acetone | µg/L | | 610 | 10 U | 10 U | 10 U |
| **Radionuclides** | | | | | | |
| Gross Alpha | pCi/L | 11 | | 2 U | 2±1 J | 2 U |
| Gross Beta | pCi/L | 17.3 | | 3±1 | 3 U | 3 U |

| WBR-12 | | WBR-13 | | WBR-15 | | WBR-76 | |
|---|---|---|---|---|---|---|---|
| RD 1 | RD 2 | RD 1 | RD 2 | RD 1 | RD 2 | RD 1 | RD 2 |
| 29-May-96 | 27-Aug-96 | 28-May-96 | 26-Aug-96 | 28-May-96 | 26-Aug-96 | 9-Jan-95 | 1-May-95 |
| 19.8 U | 57.1 K | 19.8 U | 23 U | 25.4 B | 316 K | 134 U | 137 |
| 2.3 U | 11 UL | 2.3 U | 11 UL | 2.3 U | 11 UL | 2.5 U | 2.2 U |
| 37 B | 5.4 L | 2 U | 4.1 UL | 2 U | 4.1 UL | 1.88 K | 1.7 UL |
| 13 B | 12.1 B | 26 J | 22 B | 22.3 J | 20.6 B | 19.4 | 23 U |
| 0.3 U | 0.2 UL | 0.3 U | 0.2 UL | 0.3 U | 0.2 UL | 0.8 U | 1.1 U |
| 470 | 465 K | 66.8 | 59.9 K | 18.7 B | 27.8 B | 10.5 U | NR |
| 0.4 U | 0.0005 U | 0.4 U | 0.0005 U | 0.4 U | 0.0005 U | 4.5 U | 4 U |
| 3,190 K | 2,900 K | 8,520 K | 6,920 K | 3,560 K | 3,520 K | 9,450 | 9,690 |
| 0.6 U | 4.8 UL | 0.6 U | 4.8 UL | 0.6 U | 4.8 UL | 8.3 U | 8 U |
| 9.9 B | 8.5 L | 4 B | 2.8 B | 2.7 B | 2.4 B | 18.9 | 27.8 K |
| 5 B | 3 UL | 4.1 B | 3 UL | 3.8 B | 3.5 L | 15.8 U | 12.3 B |
| 21,400 | 20,800 | 99 U | 52 U | 32,800 | 32,500 | 10,200 UL | 5,180 UL |
| 4.3 B | 2.3 UL | 1.8 B | 2.8 L | 1.7 B | 2.3 UL | 1.2 U | 2.5 B |
| 261 | 242 | 100 | 140 | 130 | 131 | 340 | 437 |
| 2,820 K | 2,780 K | 5,250 K | 4,900 K | 1,430 K | 1,450 K | 24,200 | 2,630 |
| 7.4 | 12 UL | 2.5 | 12 UL | 2.7 | 12 UL | 29.5 UL | 21 UL |
| 628 | 620 L | 1,260 | 1,240 L | 703 | 598 L | 315 | 716 B |
| 1.8 U | 3.4 UL | 1.8 U | 3.4 UL | 1.8 U | 3.4 UL | 1.7 UL | 2.8 U |
| 0.7 U | 2.8 UL | 0.7 U | 2.8 UL | 0.7 U | 2.8 UL | 1 UL | 0.7 U |
| 12,600 | 12,100 | 73,600 | 72,900 | 76,200 | 6,100 L | 8,480 | 8,390 |
| 1.8 U | 1.8 U | 1.8 U | 1.8 U | 2.6 B | 1.8 U | 2.7 UL | 2.4 U |
| 0.75 | 2.4 UL | 0.7 U | 2.4 UL | 2.1 B | 4.9 L | 0.0162 U | 29 U |
| 14.1 B | 8.4 B | 8.4 B | 9.4 B | 9.7 B | 15.3 L | 57.5 L | 194 |
| 646 UJ | 220 U | 709 UJ | 100 U | 678 UJ | 193 U | 68 UJ | 10 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.01 J | 0.05 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.03 J | 0.1 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.02 J | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.02 J | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.008 J | 0.1 U | 0.01 J | 0.1 U | 0.1 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.007 B |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1 B | 1 B | 1 B | 10 U | 10 U | 1 B | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 1 B | 10 U | 2 B | 1 B | 2 B | 2 B | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 1 J |
| 6 B | 4 B | 5 B | 5 B | 6 B | 5 B | 1 J | 5 B |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 5 B | 10 U | 5 B | 10 U | 4 B | 5 J | 10 U |
| 2 U | 2 U | 2 U | 2 U | 2 U | 2±1 | 2 U | 2 U |
| 3 U | 3 U | 4±1 | 3 U | 3 U | 3 U | 3 U | 3 U |

| CONSTITUENTS | Units | Reference Background | RBC TAP | WBR-81 RD 1 13-Jan-95 | WBR-81 RD 2 2-May-95 | WBR-82 RD 1 10-Jan-95 | WBR-82 RI 1-M |
|---|---|---|---|---|---|---|---|
| **Inorganics (Total)** | | | | | | | |
| Aluminum | µg/L | 4,370 | 37,000 | 134 U | 100 U | **6610** | 8 |
| Antimony | µg/L | 1.5 | 15 | 2.5 U | 2.2 U | 2.5 U | |
| Arsenic | µg/L | 11 | 0.045 | 1.5 U | 1.7 UL | 1.5 U | |
| Barium | µg/L | 132 | 2,600 | 21.1 | 23 U | 131 | |
| Beryllium | µg/L | 8.3 | 73 | 0.83 U | 1.1 U | **13.3** | |
| Boron | µg/L | | 3,300 | 1,870 | NR | 338 | |
| Cadmium | µg/L | 66.1 | 18 | 4.5 U | 4 U | 5.86 K | |
| Calcium | µg/L | 41,100 | | 5,290 | 4,740 | **56,200** | 48, |
| Chromium | µg/L | 5 | 110 | 8.25 U | **8.6** K | 8.3 U | |
| Cobalt | µg/L | 29 | 730 | 13.7 U | 17.8 K | **357** | |
| Copper | µg/L | 241 | 1,500 | 15.8 U | 9.9 B | 51.8 | |
| Iron | µg/L | 29,700 | 11,000 | 800 | 46 U | 180 | |
| Lead | µg/L | 436 | 15 | 2.68 K | 0.7 U | 9.39 | |
| Manganese | µg/L | 866 | 730 | 101 | 92.8 | **3,350** | 2 |
| Magnesium | µg/L | 34,000 | | 4,040 | 3,660 | **134,000** | 132 |
| Nickel | µg/L | 93 | 730 | 29.5 U | 21 UL | **308** | |
| Potassium | µg/L | 12,200 | | 5,390 | 2,140 | 3,360 | 2 |
| Selenium | µg/L | 6.25 | 180 | 1.7 UL | 2.8 U | 1.7 UL | |
| Silver | µg/L | 0.15 | 180 | 1 U | 0.7 U | 1 U | |
| Sodium | µg/L | 177,000 | | 13,400 | 22,000 | **1,020,000** | 1,200 |
| Thallium | µg/L | 2.6 | 260 | 1.5 U | 2.4 U | 2.7 UL | |
| Vanadium | µg/L | 5 | 11,000 | 0.0162 U | 29 U | 0.0162 U | |
| Zinc | µg/L | 476 | 11,000 | 38.5 B | 36.1 B | **549** | |
| Phosphorus (total) | µg/L | | | 41 UJ | 10 U | 26 UJ | |
| **Pesticides/PCBs** | | | | | | | |
| alpha-BHC | µg/L | | 0.011 | 0.05 U | 0.05 U | 0.05 U | |
| alpha-Chlordane | µg/L | | 0.19 | 0.05 U | 0.008 J | 0.05 U | |
| DDE | µg/L | | 0.2 | 0.1 U | 0.1 U | 0.02 J | |
| DDT | µg/L | | 0.2 | 0.1 U | 0.1 U | 0.1 U | |
| Endosulfan I | µg/L | | 220 | 0.05 U | 0.05 U | 0.05 U | |
| Endosulfan II | µg/L | | 220 | 0.1 U | 0.1 U | 0.1 U | |
| Endosulfan sulfate | µg/L | | | 0.1 U | 0.1 U | 0.1 U | |
| Endrin aldehyde | µg/L | | 11 | 0.1 U | 0.1 U | 0.1 U | |
| Heptachlor | µg/L | | 0.015 | 0.05 U | 0.005 B | 0.05 U | |
| Heptachlor epoxide | µg/L | | 0.0074 | 0.05 U | 0.05 U | 0.05 U | |
| **Phthalates** | | | | | | | |
| Butylbenzyl phthalate | µg/L | | | 10 U | 10 U | 10 U | |
| Bis(2-ethylhexyl)phthalate | µg/L | | 4.8 | 1 J | 10 U | 10 U | |
| Dimethylphthalate | µg/L | | 370,000 | 10 U | 10 U | 10 U | |
| Diethyl phthalate | µg/L | | 29,000 | 10 U | 10 U | 10 U | |
| Di-n-butyl phthalate | µg/L | | 3,700 | 4 J | 10 U | 10 U | |
| **Chlorinated Volatiles** | | | | | | | |
| 1,1,2,2-Tetrachloroethane | µg/L | | 0.053 | **1** J | 10 U | 10 U | |
| Chloroform | µg/L | | 0.152 | 10 U | 10 U | 10 U | |
| Methylene Chloride | µg/L | | 4.1 | 2 B | 4 B | 1 J | |
| Chloromethane | µg/L | | 2.11 | 10 U | 10 U | 10 U | |
| **Misc Volatiles & Semivolatiles** | | | | | | | |
| Acetone | µg/L | | 610 | 19 B | 10 U | 10 U | |
| **Radionuclides** | | | | | | | |
| Gross Alpha | pCi/L | 11 | | 3±1 | 2 U | 12 U | |
| Gross Beta | pCi/L | 17.3 | | 10±1 | 3±1 | 12±6 | |

| WBR-82 | | WBR-83 | | WBR-84 | | WBR-86 | |
|---|---|---|---|---|---|---|---|
| RD 1 | RD 2 | RD 1 | RD 2 | RD 1 | RD 2 | RD 1 | RD 2 |
| 10-Jan-95 | 1-May-95 | 20-Jan-95 | 4-May-95 | 10-Jan-95 | 1-May-95 | 9-Jan-95 | 2-May-95 |
| | | | | | | | |
| 6610 | 8320 | 114 | 168 | 145 | 242 | 134 U | 103 |
| 2.5 U | 2.2 U | 2.5 U | 2.2 U | 2.5 U | 3.7 | 2.5 U | 2.2 U |
| 1.5 U | 1.7 UL | 1.5 U | 1.7 UL | 1.5 U | 2 L | 1.5 U | 1.7 UL |
| 131 | 105 | 42 | 32.2 | 20.6 | 23 U | 20.7 | 23 U |
| 13.3 | 15.2 | 0.59 U | 1.1 U | 0.8 U | 1.1 U | 0.8 U | 1.1 U |
| 338 | NR | 180 | NR | 14.7 | NR | 10.5 U | NR |
| 5.86 K | 5 K | 2.32 U | 4 U | 4.5 U | 4 U | 4.5 U | 4 U |
| 56,200 | 48,600 | 6,910 | 6,190 | 5,270 | 4,890 | 4,780 | 5,070 |
| 8.3 U | 8 U | 8.37 U | 8 U | 8.3 U | 9 K | 8.3 U | 8 U |
| 357 | 303 | 68.8 | 58 K | 13.7 U | 14 U | 13.7 U | 14.5 K |
| 51.8 | 58.8 | 7.11 U | 9 U | 15.8 U | 10.4 B | 15.8 U | 9 U |
| 180 | 339 | 4,710 | 1,450 | 497 | 434 | 60 UL | 46 UL |
| 9.39 | 5.7 B | 1.74 | 1.3 | 14.2 | 0.7 U | 3.46 | 0.7 U |
| 3,350 | 2,220 | 633 | 538 | 99.9 | 143 | 249 | 258 |
| 134,000 | 132,000 | 7,990 | 7,420 | 3,520 | 4,110 | 4,020 | 3,860 |
| 308 | 289 | 61.5 | 41.3 L | 29.5 UL | 21 UL | 29.5 UL | 26.5 L |
| 3,360 | 2,650 | 1,150 L | 614 B | 5,690 | 716 B | 442 | 513 B |
| 1.7 UL | 2.8 U | 1.7 U | 2.8 U | 1.7 UL | 2.8 U | 1.7 UL | 2.8 U |
| 1 U | 0.7 U | 1.62 L | 0.7 U | 1 U | 0.7 U | 1 UL | 0.7 U |
| 1,020,000 | 1,200,000 | 27,200 | 2,680 | 1,490 | 1,160 | 8,590 | 8,180 |
| 2.7 UL | 2.4 UL | 2.7 U | 2.4 U | 2.7 UL | 2.4 U | 2.7 UL | 2.4 U |
| 0.0162 U | 29 U | 0.00807 U | 20 U | 0.0162 U | 29 U | 0.0162 U | 29 U |
| 549 | 493 | 97.6 | 109 | 8 UL | 22.8 B | 33.2 J | 44.7 B |
| 26 UJ | 10 U | 25 | 10 U | 61 UJ | 10 U | 26 UJ | 10 U |
| | | | | | | | |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.01 J | 0.05 U | 0.05 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.02 J | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.01 J | 0.05 U | 0.05 U | 0.05 U |
| 0.1 U | 0.031 J | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.031 J | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.05 U | 0.023 B | 0.5 U | 0.021 B | 0.1 J | 0.012 B | 0.5 U | 0.012 B |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| | | | | | | | |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| | | | | | | | |
| 10 U | 1 J | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 1 J | 10 U | 10 U |
| 1 J | 4 B | 2 J | 5 B | 10 U | 5 B | 10 U | 4 B |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| | | | | | | | |
| 10 U | 17 | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| | | | | | | | |
| 12 U | 16 U | 5±1 J | 2 U | 2±1 | 2 U | 2 U | 2 U |
| 12±6 | 11 U | 10±1 | 5±1 | 3 U | 3 U | 3 U | 11±2 |

| CONSTITUENTS | Units | Reference Background | RBC TAP | WBR-87 RD 1 4-Jan-95 | WBR-87 RD 2 2-May-95 | WBR-88 RD 1 4-Jan-95 |
|---|---|---|---|---|---|---|
| **Inorganics (Total)** | | | | | | |
| Aluminum | µg/L | 4,370 | 37,000 | 134 U | 109 | 134 U |
| Antimony | µg/L | 1.5 | 15 | 2.5 U | 2.2 U | 2.5 K |
| Arsenic | µg/L | 11 | 0.045 | 1.5 U | 1.7 UL | 1.5 U |
| Barium | µg/L | 132 | 2,600 | 14.6 | 23 U | 23.8 |
| Beryllium | µg/L | 8.3 | 73 | 0.8 U | 1.1 U | 0.8 U |
| Boron | µg/L | | 3,300 | 10.5 U | NR | 10.5 U |
| Cadmium | µg/L | 66.1 | 18 | 4.5 U | 4 U | 4.5 U |
| Calcium | µg/L | 41,100 | | 2,470 | 1,370 B | 5,150 |
| Chromium | µg/L | 5 | 110 | 15.7 K | 2.35 | 8.3 U |
| Cobalt | µg/L | 29 | 730 | 13.7 U | 1.4 U | 13.7 U |
| Copper | µg/L | 241 | 1,500 | 15.8 UL | 9.6 B | 15.8 UL |
| Iron | µg/L | 29,700 | 11,000 | 63 | 136 | 60 U |
| Lead | µg/L | 436 | 15 | 1.2 UL | 0.7 U | 2.02 L |
| Manganese | µg/L | 866 | 730 | 62.4 | 36.5 | 181 |
| Magnesium | µg/L | 34,000 | | 636 | 661 | 4,190 |
| Nickel | µg/L | 93 | 730 | 29.5 U | 21 UL | 29.5 U |
| Potassium | µg/L | 12,200 | | 594 | 309 B | 327 |
| Selenium | µg/L | 6.25 | 180 | 1.7 UL | 2.8 UL | 1.7 UL |
| Silver | µg/L | 0.15 | 180 | 1 UL | 0.7 UL | 1 UL |
| Sodium | µg/L | 177,000 | | 4,880 | 4,920 | 1,090 |
| Thallium | µg/L | 2.6 | 260 | 2.7 UL | 2.4 U | 2.7 UL |
| Vanadium | µg/L | 5 | 11,000 | 0.0162 U | 29 U | 0.0162 U |
| Zinc | µg/L | 476 | 11,000 | 24.4 B | 15.4 B | 46.1 B |
| Phosphorus (total) | µg/L | | | 33 UJ | 10 U | 30 UJ |
| **Pesticides/PCBs** | | | | | | |
| alpha-BHC | µg/L | | 0.011 | 0.05 U | 0.05 U | 0.03 J |
| alpha-Chlordane | µg/L | | 0.19 | 0.05 U | 0.05 U | 0.05 U |
| DDE | µg/L | | 0.2 | 0.1 U | 0.1 U | 0.1 U |
| DDT | µg/L | | 0.2 | 0.1 U | 0.1 U | 0.1 U |
| Endosulfan I | µg/L | | 220 | 0.05 U | 0.05 U | 0.05 U |
| Endosulfan II | µg/L | | 220 | 0.1 U | 0.1 U | 0.1 U |
| Endosulfan sulfate | µg/L | | | 0.1 U | 0.1 U | 0.1 U |
| Endrin aldehyde | µg/L | | 11 | 0.01 U | 0.1 U | 0.03 J |
| Heptachlor | µg/L | | 0.015 | 0.02 J | 0.05 U | 0.04 J |
| Heptachlor epoxide | µg/L | | 0.0074 | 0.05 U | 0.05 U | 0.05 U |
| **Phthalates** | | | | | | |
| Butylbenzyl phthalate | µg/L | | | 1 B | 10 U | 10 U |
| Bis(2-ethylhexyl)phthalate | µg/L | | 4.8 | 10 U | 10 U | 10 U |
| Dimethylphthalate | µg/L | | 370,000 | 10 U | 10 U | 10 U |
| Diethyl phthalate | µg/L | | 29,000 | 10 U | 10 U | 10 U |
| Di-n-butyl phthalate | µg/L | | 3,700 | 2 B | 10 U | 1 J |
| **Chlorinated Volatiles** | | | | | | |
| 1,1,2,2-Tetrachloroethane | µg/L | | 0.053 | 10 U | 10 U | 10 U |
| Chloroform | µg/L | | 0.152 | 10 U | 10 U | 10 U |
| Methylene Chloride | µg/L | | 4.1 | 1 J | 4 B | 2 J |
| Chloromethane | µg/L | | 2.11 | 10 U | 10 U | 10 U |
| **Misc Volatiles & Semivolatiles** | | | | | | |
| Acetone | µg/L | | 610 | 4 J | 10 U | 10 U |
| **Radionuclides** | | | | | | |
| Gross Alpha | pCi/L | 11 | | 2 U | 2 U | 2 U |
| Gross Beta | pCi/L | 17.3 | | 3 U | 3 U | 3 U |

| WBR-88 | | WBR-70 | | WBR-74 | | WBR-75 | |
|---|---|---|---|---|---|---|---|
| RD 1 | RD 2 | RD 1 | RD 2 | RD 1 | RD 2 | RD 1 | RD 2 |
| 4-Jan-95 | 2-May-95 | 9-Feb-95 | 7-Jun-95 | 10-Feb-95 | 8-Jun-95 | 10-Feb-95 | 6-Jun-95 |
| 134 U | 147 | 108 | 184 B | 258 L | 201 B | 90.3 UL | 92 U |
| 2.5 K | 2.2 U | 2.2 UL | 1.7 UL | 2.2 UL | 1.7 UL | 2.2 UL | 1.7 U |
| 1.5 U | 1.7 UL | 1.7 U | 1.8 U | 1.7 U | 1.8 U | 13.2 | 15.8 |
| 23.8 | 23 U | 78.4 | 70 B | 82.4 | 72.7 B | 25.7 B | 24.5 |
| 0.8 U | 1.1 U | 1.07 U | 1.1 UL | 1.07 U | 1.1 UL | 1.07 U | 1.1 UL |
| 10.5 U | NR | 27.7 | NR | 87.7 | NR | 331 | NR |
| 4.5 U | 4 U | 3.3 U | 3 U | 3.3 U | 3 U | 3.3 U | 3 U |
| 5,150 | 3,100 | 1,430 | 11,900 B | 1,160 | 10,900 B | 7,300 | 8,210 K |
| 8.3 U | 8 U | 9.1 UL | 8 UJ | 9.1 UL | 10.6 B | 9.1 UL | 8 UJ |
| 13.7 U | 17.1 K | 14.4 U | 13 U | 27.7 | 13 U | 24.8 | 19.4 |
| 15.8 UL | 9 U | 11.9 UL | 23 U | 11.9 UL | 23 U | 11.9 UL | 23 U |
| 60 U | 83 | 3,150 | 29,700 | 300 | 183 B | 2,500 | 31,700 |
| 2.02 L | 0.7 U | 1 UL | 0.9 | 1 UL | 0.9 UL | 1 UL | 0.9 U |
| 181 | 100 | 548 B | 481 B | 556 | 462 B | 1,790 | 1,880 |
| 4,190 | 5,680 | 5,340 B | 4,920 B | 1,140 | 10,700 B | 1,240 | 14,700 |
| 29.5 U | 21 UL | 25.5 U | 21 U | 37.8 K | 26 K | 25.5 U | 21 U |
| 327 | 163 UL | 1290 B | 1470 B | 828 | 785 B | 597 | 785 |
| 1.7 UL | 2.8 UL | 2.8 U | 2 | 2.8 U | 1.6 U | 2.8 U | 2 L |
| 1 UL | 0.7 UL | 0.7 UL | 0.7 UL | 0.7 UL | 0.7 UL | 0.7 UL | 0.7 UL |
| 1,090 | 9,630 | 14,000 K | 12,700 B | 21,600 K | 20,400 B | 16,600 K | 17,300 |
| 2.7 UL | 2.4 U | 2.4 UL | 2.8 UL | 2.4 UL | 2.8 UL | 2.4 UL | 2.8 U |
| 0.0162 U | 29 U | 14.2 U | 29 U | 14.2 U | 29 U | 14.2 U | 29 U |
| 46.1 B | 39.8 B | 13.6 | 12 U | 84.2 | 54.9 B | 12.2 | 14.8 |
| 30 UJ | 10 U | 19,600 | 9,730 UJ | 13 | 12,200 UJ | 16 | 10 U |
| 0.03 J | 0.006 J | 0.05 U | 0.05 U | 0.05 U | .0.5 U | 0.05 U | 0.05 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1. U | 0.1 U | 0.1 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.03 J | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.006 J | 0.1 U | 0.01 UL |
| 0.04 J | 0.01 B | 0.05 U | 0.019 B | 0.05 U | 0.007 B | 0.05 U | 0.038 B |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.004 J | 0.05 U | 0.05 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1 J | 10 U | 1 J | 1 J | 2 J | 1 J | 1 J | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 1 B | 2 J | 10 U | 10 U |
| 2 J | 10 U | 2 B | 4 B | 2 B | 4 B | 2 B | 3 B |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 3 B | 10.4 B | 18 B | 13 B | 10 U |
| 2 U | 2 U | 2 U | 2±1 J | 2 U | 2 U | 2 U | 2 U |
| 3 U | 3 U | 3 U | 3 U | 31±4 J | 3±1 J | 3 U | 61±2 |

| CONSTITUENTS | Units | Reference Background | RBC TAP | WBR-77 RD 1 8-Feb-95 | WBR-77 RD 2 6-Jun-95 | RD 9-Feb |
|---|---|---|---|---|---|---|
| **Inorganics (Total)** | | | | | | |
| Aluminum | µg/L | 4,370 | 37,000 | 90.3 U | 92 U | 1 |
| Antimony | µg/L | 1.5 | 15 | 2.2 UL | 1.7 UL | |
| Arsenic | µg/L | 11 | 0.045 | 1.7 U | 1.8 U | 3 |
| Barium | µg/L | 132 | 2,600 | **164** | **167** | |
| Beryllium | µg/L | 8.3 | 73 | 1.07 U | 1.1 UL | 1 |
| Boron | µg/L | | 3,300 | 30.8 | NR | 2 |
| Cadmium | µg/L | 66.1 | 18 | 3.3 U | 3 U | |
| Calcium | µg/L | 41,100 | | 2,120 | 21,400 | 2,2 |
| Chromium | µg/L | 5 | 110 | 9.1 UL | 8 UJ | |
| Cobalt | µg/L | 29 | 730 | 14.4 U | 13 U | |
| Copper | µg/L | 241 | 1,500 | 11.9 UL | 23 U | |
| Iron | µg/L | 29,700 | 11,000 | **45,700** | **47,100** | 51,0 |
| Lead | µg/L | 436 | 15 | 1 UL | 0.9 UL | 2 |
| Manganese | µg/L | 866 | 730 | **756** | **730** | |
| Magnesium | µg/L | 34,000 | | 4,230 | 4,400 K | 7,7 |
| Nickel | µg/L | 93 | 730 | 25.5 U | 21 U | 2 |
| Potassium | µg/L | 12,200 | | 9,160 | 5,840 | 1,8 |
| Selenium | µg/L | 6.25 | 180 | 2.8 U | 1.6 UL | |
| Silver | µg/L | 0.15 | 180 | 0.7 UL | 0.7 UL | |
| Sodium | µg/L | 177,000 | | 18,600 K | 18,200 | 42,9 |
| Thallium | µg/L | 2.6 | 260 | 2.4 UL | 2.8 U | |
| Vanadium | µg/L | 5 | 11,000 | 14.2 U | 29 U | 1 |
| Zinc | µg/L | 476 | 11,000 | 8.24 | 12 U | 1 |
| Phosphorus (total) | µg/L | | | 10 U | 12,400 UJ | 5 |
| **Pesticides/PCBs** | | | | | | |
| alpha-BHC | µg/L | | 0.011 | 0.05 U | 0.05 UL | 0 |
| alpha-Chlordane | µg/L | | 0.19 | 0.05 U | 0.05 U | 0 |
| DDE | µg/L | | 0.2 | 0.1 U | 0.1 U | |
| DDT | µg/L | | 0.2 | 0.1 U | 0.1 U | |
| Endosulfan I | µg/L | | 220 | 0.05 U | 0.05 U | 0 |
| Endosulfan II | µg/L | | 220 | 0.1 U | 0.1 U | |
| Endosulfan sulfate | µg/L | | | 0.1 U | 0.1 U | |
| Endrin aldehyde | µg/L | | 11 | 0.1 U | 0.1 UL | |
| Heptachlor | µg/L | | 0.015 | 0.05 U | 0.05 UL | 0 |
| Heptachlor epoxide | µg/L | | 0.0074 | 0.05 U | 0.05 UL | 0 |
| **Phthalates** | | | | | | |
| Butylbenzyl phthalate | µg/L | | | 10 U | 10 U | |
| Bis(2-ethylhexyl)phthalate | µg/L | | 4.8 | 2 J | 10 U | |
| Dimethylphthalate | µg/L | | 370,000 | 10 U | 10 U | |
| Diethyl phthalate | µg/L | | 29,000 | 10 U | 10 U | |
| Di-n-butyl phthalate | µg/L | | 3,700 | 10 U | 2 J | |
| **Chlorinated Volatiles** | | | | | | |
| 1,1,2,2-Tetrachloroethane | µg/L | | 0.053 | 10 U | 10 U | |
| Chloroform | µg/L | | 0.152 | 10 U | 10 U | |
| Methylene Chloride | µg/L | | 4.1 | 2 B | 2 B | |
| Chloromethane | µg/L | | 2.11 | 10 U | 10 U | |
| **Misc Volatiles & Semivolatiles** | | | | | | |
| Acetone | µg/L | | 610 | 10 U | 4 B | |
| **Radionuclides** | | | | | | |
| Gross Alpha | pCi/L | 11 | | 2 U | 2±1 | |
| Gross Beta | pCi/L | 17.3 | | 5±1 | 3 U | |

| WBR-78 | | WBR-79 | | WBR-80 | |
|---|---|---|---|---|---|
| RD 1 | RD 2 | RD 1 | RD 2 | RD 1 | RD 2 |
| 9-Feb-95 | 7-Jun-95 | 8-Feb-95 | 6-Jun-95 | 13-Feb-95 | 6-Jun-95 |
| 145 L | 92 U | 223 | 544 B | 90.3 U | 92 U |
| 2.2 UL | 1.7 UL | 0.22 UL | 1.7 U | 0.22 UJ | 1.7 U |
| 3.06 | 2.6 | 1.7 U | 1.8 U | 6.57 | 3 |
| 105 | 111 B | 28 | 29.3 | 13.2 | 25.3 |
| 1.07 U | 1.1 UL | 1.07 U | 1.1 UL | 1.07 U | 1.1 U |
| 21.5 | NR | 304 | NR | 40.7 | NR |
| 3.3 U | 4.4 B | 3.3 U | 3 U | 4.5 U | 3 U |
| 2,220 | 20,600 B | 5,090 | 5,040 K | 4,970 | 5,300 K |
| 9.1 UL | 8 UJ | 9.1 UL | 8 UJ | 9.1 U | 8 UJ |
| 14.4 U | 13 U | 14.4 U | 13 U | 17 | 13 U |
| 11.9 UL | 23 U | 11.9 UL | 23 U | 14.2 B | 23 U |
| 51,000 | 55,900 | 11,200 | 8,540 | 1,810 | 18,600 |
| 2.52 L | 0.9 U | 1.48 L | 1 L | 1 UL | 0.9 UL |
| 705 | 692 B | 334 | 307 | 274 | 291 |
| 7,730 | 8,220 B | 32,900 | 3,340 K | 5,670 | 7,130 K |
| 25.5 U | 21 U | 25.5 U | 22.5 K | 25.5 U | 21 U |
| 1,870 | 1,700 B | 1,980 | 1,240 | 335 L | 2,160 |
| 2.8 U | 1.6 U | 2.8 UL | 1.6 UL | 2.8 U | 1.6 UL |
| 0.7 UL | 0.7 UL | 0.7 UL | 0.7 UL | 0.7 UL | 0.7 UL |
| 42,900 K | 41,100 B | 43,700 K | 38,600 | 24,900 | 25,500 |
| 2.4 UL | 2.8 UL | 2.4 UL | 2.8 U | 2.4 U | 2.8 U |
| 14.2 U | 29 U | 14.2 U | 29 U | 14.2 UL | 29 U |
| 16.6 | 12 U | 25.1 | 22.2 | 12.7 B | 52.9 |
| 537 | 10,900 UJ | 10 U | 8,380 UJ | R | 6,680 UJ |
| 0.05 U | 0.05 UL | 0.05 U | 0.05 U | 0.01 J | 0.05 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.1 U | 0.1 UL | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 U | 0.1 J | 0.1 U | 0.1 U | 0.1 U |
| 0.1 U | 0.1 UL | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 0.05 U | 0.05 UL | 0.05 U | 0.05 U | 0.05 U | 0.05 U |
| 0.05 U | 0.05 UL | 0.05 U | 0.05 U | 0.05 U | 0.008 J |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 10 U | 1 J | 1 J | 2 J | 10 U | 10 U |
| 10 U | 10 U | 10 U | 10 UJ | 10 U | 10 UJ |
| 10 U | 10 U | 10 U | 10 UJ | 10 U | 10 UJ |
| 2 B | 3 B | 3 B | 10 UJ | 2 B | 3 B |
| 10 U | 10 U | 10 U | 10 U | 10 U | 10 UJ |
| 10 U | 10 U | 6 B | 10 UJ | 10 U | 10 UJ |
| 3 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| 3 U | 3 U | 5±2 | 3 U | 3 U | 3 U |